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Christmas Greetings

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A MOMENT WITH THE PUBLISHERS

To Administer RECOVERY

IN the course of an address to the Investment Bankers Association, James M. Landis, chairman of the Securities and Exchange Commission, recently used an expression that deserves more than passing notice.

He spoke of the "shift in emphasis from administering to a depression to administering a recovery." And in that phrase he embodied the issue that is drawn between those who advocate more centralized economic planning by government and those who resist any curtailment of the free initiative of business and business men.

This will be evident if we remember that a depression does not just happen. It is the direct result of a failure in administering prosperity. An automobile accident may result from any one of several direct causes but fundamentally it is due to some failure in "administering" motor traffic. Something is wrong with the circumstances of the car's progress. Maybe it is going too fast for the conditions; possibly the driver is inattentive; perhaps there is a defect in the car. But disaster, whether to automobile or to the economic mechanism, is not the result of some mystical visitation; it is the result of some cause that actually is in operation while those concerned are quite content to be riding high, wide and handsome. The depression of the thirties surely was caused during the "good times" of the twenties.

WHEN a crash comes, of course, all progress must be suspended while we care for the victims, clear away the wreckage and resume traffic. That is the process of "administering to a depression." It calls for certain distinctive qualities and measures that are adapted to dealing with emergencies; usually they must be exercised by some strong hand that either has or assumes the necessary authority.

But once the effects of the accident are overcome, and normal traffic is resumed, we must "administer" the recovery. It is important to recognize that this involves far more than merely restoring the conditions that prevailed before the crash. It implies open-minded and searching inquiry into the causes and an equally open-minded and honest effort to remove them.

Recovery that merely restores the right of everyone to carry on with the same performance that caused the crash is but a prelude to the next disaster. Certainly, if we are to administer our recovery effectively, we must resume our progress with due care to prevent a new collapse.

Right here is where reactionary and radical lock horns. The radical, who sees no remedy for periodic disaster aside from federal administration and control, trades on the psychology of the emergency and tries to perpetuate and extend the controls that have been improvised to deal with it. The reactionary, who resents any infringement of his individual will, resists any effort to apply whatever lessons we may have learned and demands that he be permitted forthwith to go his way as before. To him such calamities are but acts of God.

Neither of these views appears to be in keeping with human experience. The true conservative and the true progressive, however they may differ in the matter of degree, both know that such extreme views contribute nothing to long-term progress.

That is why it is encouraging to day to see spokesmen for both government and business moving toward each other in search of reasonable ground on which to administer the current recovery and the prosperity it foreshadows.

ONLY the blind and self-centered few will demand the return of conditions that must breed a new collapse; only the reckless and uninformed few will clamor for the overthrow of a system that, despite its failings, has to its credit so much real progress.

The time has come for all hands to cease bickering about words and phrases and to define more sharply a few specific objectives. It is time to concentrate on administering our recovery, whatever may be its sources, so that we may enjoy our next prosperity more sanely and more surely. Here is a job that deserves the most enlightened efforts of government, of organized business and of the individual business man himself. It looks now as though it is going to have them.

Willard Chevalier

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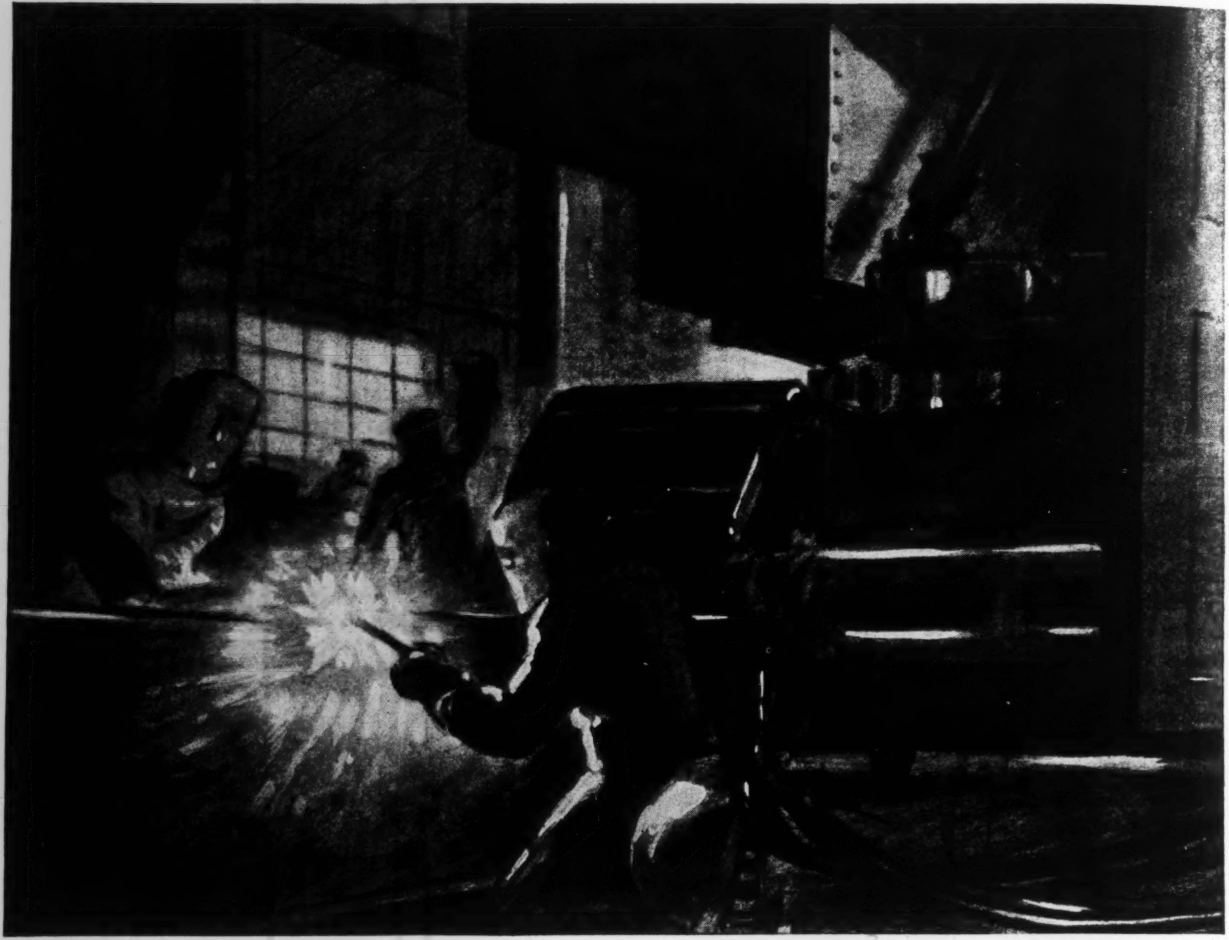

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DECEMBER 24, 1936

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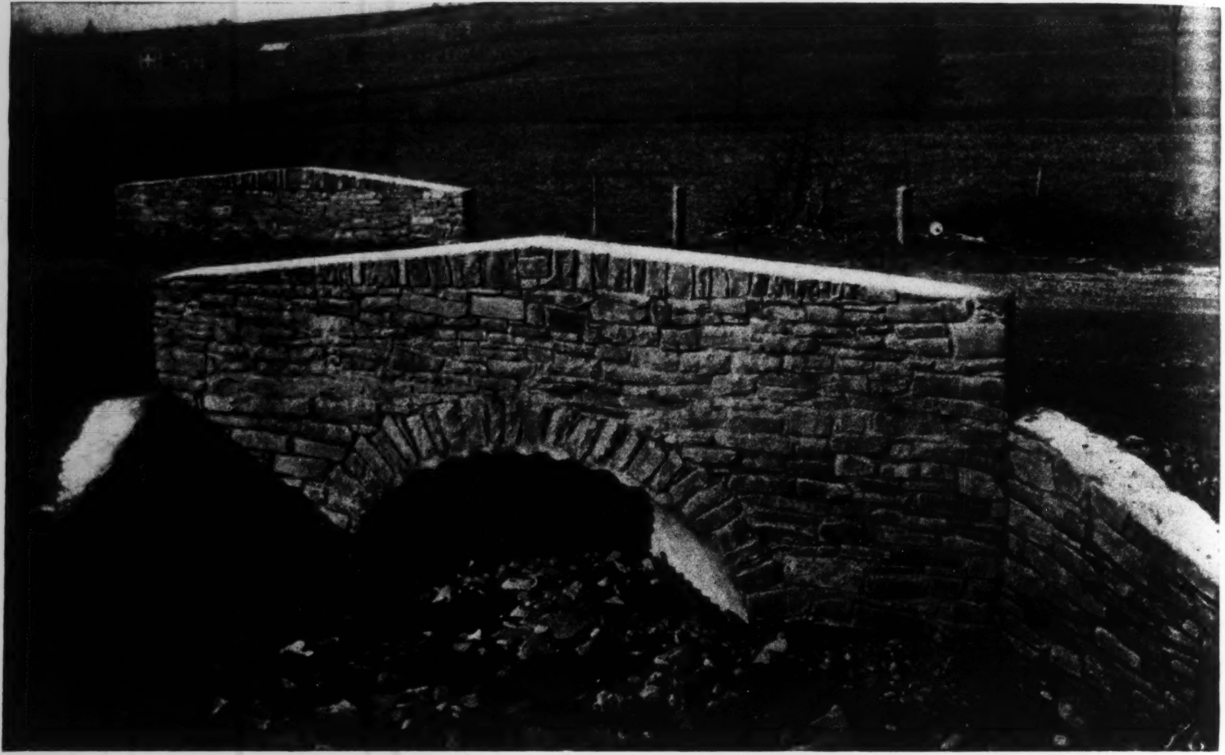
■

Off The Streets—THIS YEAR SYRACUSE celebrated the removal of the New York Central tracks from the surface of the city's major streets, a position they had occupied for nearly a century. In this issue is told the story of the long effort to take the tracks off the streets. It points clearly to the need for broad vision in planning community services so they will not become a restriction or will themselves become restricted in future years. Both the city and the railroad have benefited by the change but the cost is high.

A Smart Way to *Cut* Costs

IN CULVERT CONSTRUCTION



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ENGINEERING NEWS-RECORD

December 24, 1936

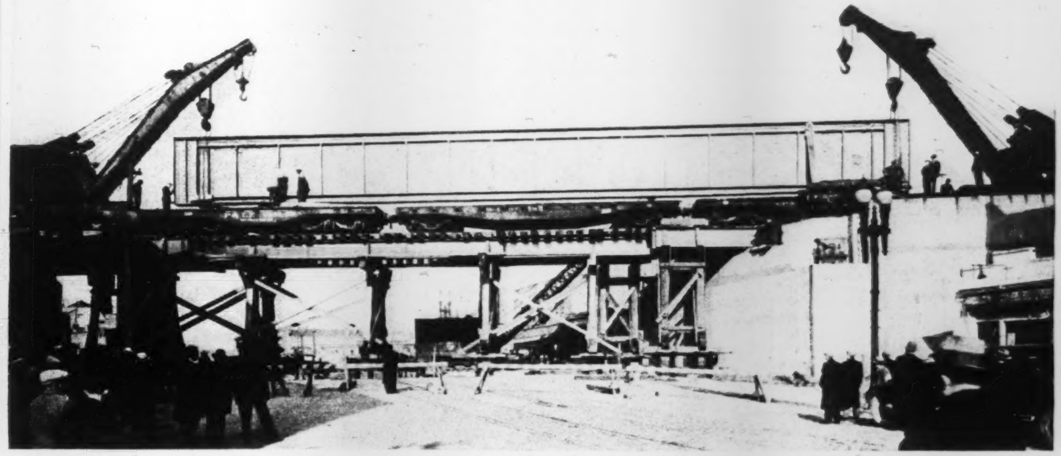


FIG. 1—SETTING A 147-TON GIRDER at Salina for one of 31 bridges in the Syracuse track elevation project.

New York Central Elevates Five Miles of Track Through Syracuse

Trains taken off main business streets for first time in 97 years upon completion of extensive track elevation project involving 31 bridges, heavy fills and new station on the West Shore R.R. right-of-way

FOR 97 years the main line trains of the New York Central R.R. traversed Syracuse, N. Y., at grade, running along Washington St. and crossing all of the main business thoroughfares, thus splitting the business district into two parts. In olden days when street traffic was light and train operation was comparatively slow, the inconvenience to the public and the railroad in street-level train operation was of no great importance. However, in recent years, 100 daily train movements over the 1¼-mile length of Washington St., in which sixteen business streets were intersected, repeatedly snarled the traffic of the city and inconvenienced the railroad and public alike. Similar conditions on a much smaller scale prevailed on a parallel location four blocks to the north where trains of the West Shore R.R. for 53 years crossed 24 streets at grade within a distance of 3½ miles.

On Sept. 24 of this year street-level operation of both railroads through Syracuse ended with the completion of a five-mile track elevation project built generally along the route of the West Shore line. The new elevation consists of three main tracks which have replaced the old double-track main line in Washington St. and the original double-track of the West Shore RR. The old New York Central tracks have been abandoned through the heart of the city except for certain industrial sidings.

Funds for the grade separation work were obtained from the New York state $300,000,000 grade elimination bond issue, the railroad company's share of 50 per cent being in the form of a loan.

Involved in the project are 31 bridges, including one large box culvert and three overhead street viaducts, about 8,000 ft. of retaining wall, 1,500,000 cu. yd. of fill, a new passenger station, express and mail buildings, new freight and coach yards, branch line connection changes and a complete new signal installation. Several of the bridges are notable for a two-girder design carrying three tracks over long spans.

Elimination long advocated

The first franchise for a railroad through Syracuse was granted in 1837 to the Syracuse & Utica, now a part of the New York Central system. In 1839 the line was opened in Washington St. In 1854 the D. L. & W. built into the town from the south, but its tracks are not involved in the present project. As far back as the early 70's, New York Central freight train operation through the city caused delays, and in 1873 the railroad built the Syracuse Junction R.R., a freight bypass line around to the north of the city. In 1883 the West Shore R.R. was completed through Syracuse, traversing the city on an independent right-of-way about four blocks north of the New York Central R.R. Later this road was leased by the New York Central and at present its operation through Syracuse is confined solely to freight traffic.

The first definite move toward elimination of the grade crossings through the city was made by Mayor Joseph K. Maguire, who in 1898 appointed H. B. Seaman to study the problem and to make recommendations. His report advocated the combining of the West Shore and New York Central lines on an elevation along the West Shore location, the identical plan that was followed in general, except for the passenger station location, after three decades of delay in which every other possible scheme was considered and finally abandoned. In 1911 the Syracuse Common Council created the Syracuse Grade Crossing Commission of five members, and in 1912 the state legislature clothed the commission with authority to initiate the work. The commission then appointed Henry C. Allen, the city engineer, as engineer to proceed with plans.

In the next five years of planning a scheme of utilizing the old Erie Canal bed as a railway subway gained the favor of the commission, and the elevated plan was forgotten. The canal, then an open ditch, and now filled for use as a boulevard, was about to be replaced by the New York State Barge Canal. Bion J. Arnold, acting as consultant to the commission, reviewed the canal bed plans and approved the scheme in 1917. Before further action could be taken, the country was at war and the plans were shelved.

In 1922 the commission again reviewed and approved the canal conversion plan, only to have it rejected by the city council. In desperation the commission submitted plans for the West Shore elevation in 1924, only to have these likewise meet rejection by the council which, by this time, wanted the railroads taken out of the city entirely and shunted around the Syracuse Junction line. Opposition to this scheme by the commission brought all planning to a standstill in 1925.

The commission then submitted the names of ten consulting engineers to the State Supreme Court justices with the request that one be selected to make a study and report of the elimination problem. Frederick H. Fay, of Boston, was chosen by the court, and in 1927 he submitted a report advocating the West Shore elevation scheme. In November, 1927, the votors of the city voiced approval of this plan. Nelson F. Pitts, Jr., city engineer, was made chief engineer of the Syracuse Grade Crossing Commission, and in 1928 the first petition was made to the State Public Service Commission, from which the first order was received in 1929.

Actual construction commenced in 1930, with the award of contract for an overhead highway viaduct carrying Thompson Road, at the extreme eastern end of the project, over the intersection of the West Shore and New York Central lines. The Midler Ave. viaduct over the West Shore tracks was built in 1931, and the Peat St. freight yards and perishable freight tracks were completed in 1932, all the foregoing being preliminary to the main elevation work. The general contract for the remaining 29 bridges, retaining walls, fills and station platforms was let in December, 1933, to the Walsh Construction Co. of Syracuse and Davenport, Iowa. The New York Central R.R. Co. did the track and signal work.

Near the eastern end of the city, where the new freight yard has been built, a new three-track connection from the old New York Central main line takes off on a slight upgrade to intercept the old West Shore line at the most easterly railroad bridge in the project at Peat St. There are two adjacent bridges over Peat St., one carrying the single-track main line of the West Shore, while the other carries the two tracks of the N.Y.C.R.R. From this point westward for some five miles the old West Shore double-track line has been replaced with the new three-track elevated line (Fig. 3). Five bridges are crossed by the new line in rapid order to just east of the Crouse Ave. bridge, where the tracks begin to fan out into ten long station tracks, converging again west of the span over Catherine St. Between the station tracks are five long platforms, aggregating nearly two miles in length, accommodating trains of ten to twenty coaches each. Also within the station area are numerous sub-tracks for coach and power handling service to mail and express facilities.

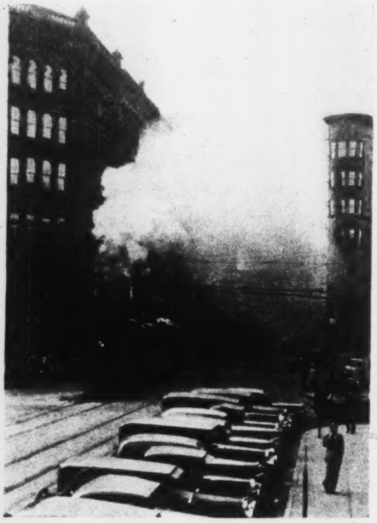


FIG. 2—FOR 97 YEARS Washington St. was the main line of the New York Central through Syracuse.

The new station was built on the south side of the tracks facing Erie Blvd., a new east-and-west thoroughfare. Scores of buildings were demolished to make way for the station, tracks and plaza. The station structure is of three-story and four-story construction, faced with brick and limestone. The waiting room is a revelation to travelers, for within a most attractive room finished in travertine and marble are groups of red leather settees and chairs, placed on rugs, and arranged in informal fashion. Numerous writing desks are scattered throughout the room, and the whole gives the impression of a modern hotel lobby instead of a railroad station.

After crossing two more bridges a short distance west of the station, the new line enters the main business district, cutting diagonally across five streets requiring bridges of unusually heavy design and special architectural treatment. West of the business district the line crosses two more street bridges and then passes over Onondaga Creek on a four-span deck girder structure. A single span north of the main line carries an industrial lead track across the creek at a lower level. Westward from the creek the new route is now elevated over three streets where the original West Shore line was at grade. From Van Rensselaer St. westward the original low double-track embankment of the West Shore has been widened and raised to accommodate three tracks and four streets formerly crossed by West Shore bridges are now spanned by new structures at a higher elevation. The new line of the N.Y.C.R.R. leaves the original West Shore location west of Hiawatha St. on a new tangent 3,000 ft. long, which crosses Harbor Brook on a double-box culvert, the last of the bridges, and intercepts the old main line of the Central near the westerly city limits. Here a new interlocking tower has been built to serve the N. Y. C. R.R. main line, the West Shore main line, the Syracuse Junction branch and the Auburn branch.

Industries are served by several leads from the new main line and by leaving the original N.Y.C. R.R. tracks in place from the east as far as Irving Ave. The old West St. yards, west of the abandoned passenger station, will remain in service through a connection from the west over the old main line. Through the center of town the original New York Central tracks will be torn up.

To elevate the main line through the business district without excessive land costs required the building of 8,000 ft. of retaining walls, extending almost unbrokenly from Crouse Ave. to Onondaga Creek. Most of the walls are either of cantilever or gravity section, but in a few places concrete cribbing was found suitable, especially alongside an old brick church where foundation excavation for masonry walls would have endangered the edifice.

Principal quantities involved in the project, exclusive of buildings, are: structure excavation, 100,000 cu. yd.; concrete piles, 200,000 lin. ft.; timber piles, 100,000 lin. ft.; concrete, 120,000 cu. yd.; structural steel, 14,000 tons; reinforcing, 3,000,000 lb.; embankment fill, 1,500,000 cu. yd. This last item is pit run sand and gravel, containing less than 20 per cent clay or loam.

Foundation problems

Foundations presented a special problem, for much of the line traverses swamp land, peat bogs and soft clay soil. Hardpan and rock exist at widely varying elevations, from 12 to 25 ft.

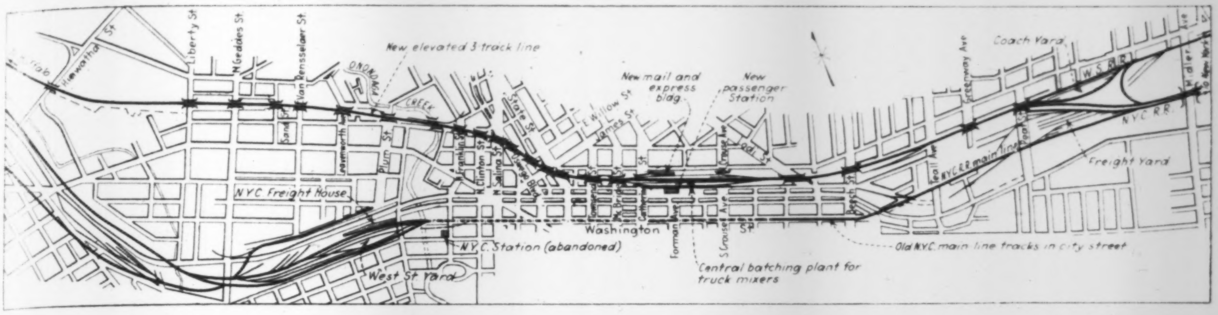
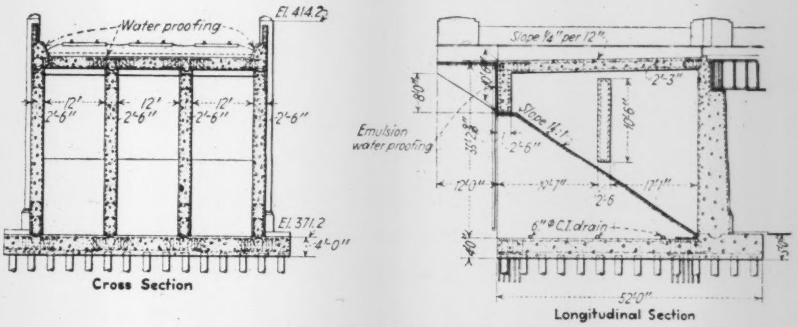

Hiawatha St
Liberty St
N Geddes St
Van Rensselaer St
Sand St
Leavenworth Ave
Plum St
ONONDAGA CREEK
New elevated 3 track line
N Franklin St
N Clinton St
N Salina St
State St
E Willow St
James St
New mail and express bldg.
New passenger Station
Townsend St
Pk Bridge St
Catherine St
Forman Ave
S Crouse Ave
Crouse Ave
Lodi St
Beech St
Teall Ave
Greenway Ave
Pearl St
Hidler Ave
Coach Yard
W.S.R.R.
N.Y.C.R.R.
NYC R.R. main line
Freight Yard
NYC Freight House
Washington St
N.Y.C. Station (abandoned)
West St Yard
Central batching plant for truck mixers
Old N.Y.C. main line tracks in city street

FIG. 3—FIVE MILES of track elevation were required to take the N.Y.C.R.R. and West Shore trains off the streets.

below the surface in the central section, up to 50 ft. in depth in the eastern end of town, and at unknown depths west of Onondaga Creek, where 90-ft. borings reveal nothing but soft muck. At several bridge locations a layer of peat 6 ft to 12 ft. deep overlies a soft sand and clay formation, which complicated the foundation design.

Changes in design of foundations of some of the masonry structures were found necessary after additional test borings and driving of test piles revealed the true character of the ground. Original plans called for wood piling under many of the bridges, but in some locations east of Onondaga Creek it was found that because of the difficulty in driving piles far enough into the hard pan to obtain a toehold the piles would be too short to provide lateral stability. In several such locations concrete piles were used in place of wood as bearing piles, and wood batter piles were driven for stability; in other places the piles were omitted and the footings were carried down to hardpan or rock. Concrete piles were used in connection with wood batter piles under all of the retaining walls not resting on hardpan. All concrete piles are of the cast-in-place type, reinforced in the top 15 ft. of length. Wood batter piles are of creosoted timber.

In the central and eastern sections the abutments are of the conventional gravity type. At the extreme westerly end of the project, however, foundation conditions required special treatment, for the abutments of four bridges. Here the ground is swampy, requiring long piles depending upon skin friction alone for bearing power. Batter piles were considered inadequate to provide the necessary lateral stability to resist the end thrust of a high fill. Consequently, the abutments were designed as cellular boxes, open at the back end to permit the end of the fill to take a normal slope within the abutment and thereby eliminate most of the end thrust. The abutments consist of a heavily reinforced concrete mat 52 ft. square and 4 ft. thick, resting on 210 concrete piles, a heavy slightly battered face wall, four 30-in. longitudinal walls and a 27-in. deck (Fig. 4).


Water proofing
El. 414.2
12'
2'-6"
12'
2'-6"
12'
2'-6"
2'-6"
El. 371.2
4'-0"
Slope ¼" per 12"
2'-3"
8'0"
10'6"
Slope 1½:1
10'6"
Emulsion water proofing
35'2⅞"
2'-6"
12'0"
10'7"
2'6
17'1"
6" ⌀ C.I. drain
4'0"
5'0"
52'0"

Cross Section

Longitudinal Section

CELLULAR ABUTMENTS AT WEST END BRIDGES

FIG. 4—BOTTOMLESS MUCK at the four westerly street crossings offered but little lateral stability for the abutments, so the structures were designed as cellular open boxes to relieve most of the end thrust of a high fill.

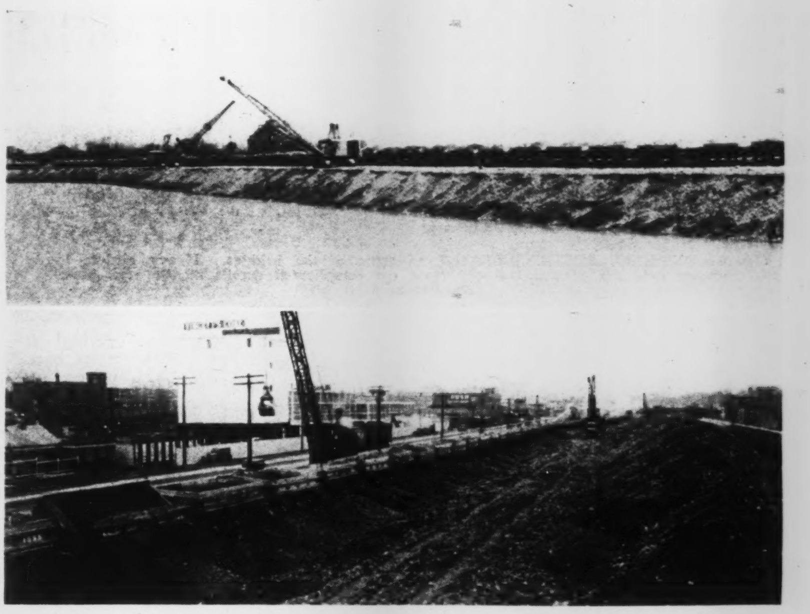
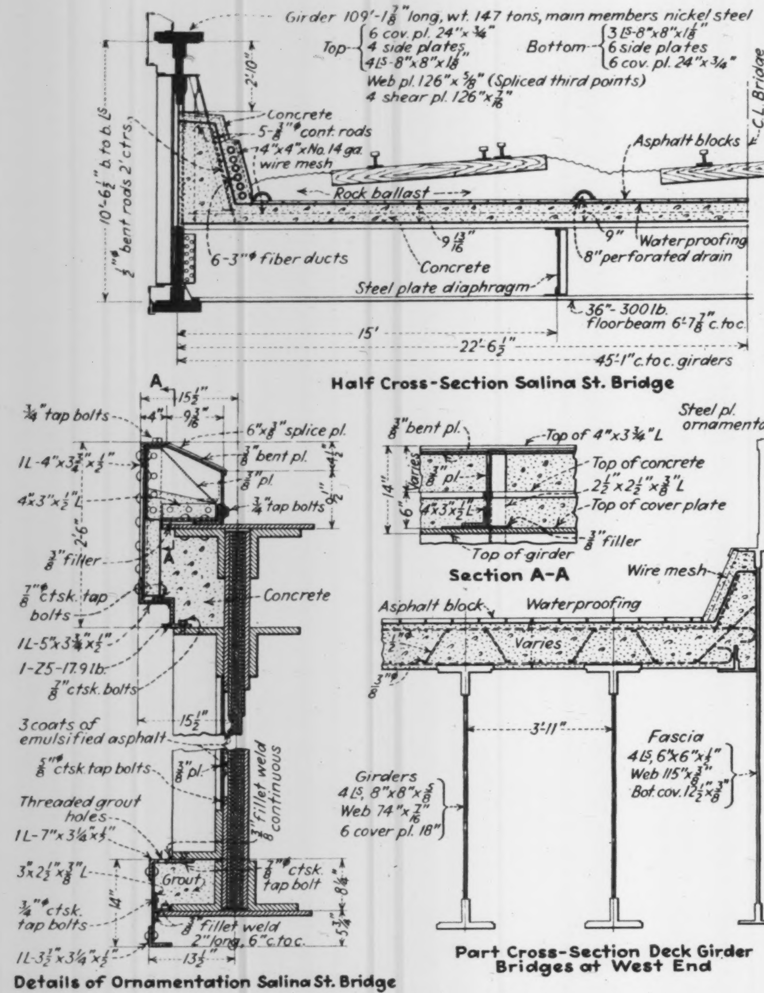


FIG. 5—A MILLION AND A HALF yards of sand and gravel were excavated from a wet pit and hauled 9 miles to the fill. The lower view shows the method of building up the first track; fill material was dumped into a trench and sidecast into the fill by draglines.

Three types of superstructure

To meet varying local conditions three general types of steel superstructure were required, exclusive of the overhead viaducts. Each of the bridges was given special ornamentation and architectural treatment, and all exposed steelwork has been painted with aluminum, resulting in attractive structures throughout. Every one of the railroad bridges has a solid deck carrying ballasted track.

Beam Bridges—In the extreme eastern section the controlling factor in structure design was the low street clearances, which required as shallow a bridge floor construction as possible. In brief, the steel design consisted of rolled-beam longitudinal stringers carry-


Half Cross-Section Salina St. Bridge

Details of Ornamentation Salina St. Bridge

Section A-A

Part Cross-Section Deck Girder Bridges at West End

Girder 109'-1 7/8" long, wt. 147 tons, main members nickel steel
Top
6 cov. pl. 24"x 3/4"
4 side plates
4 Ls-8"x8"x1 1/8"
Bottom
3 Ls-8"x8"x1 1/8"
6 side plates
6 cov. pl. 24"x 3/4"
Web pl. 126"x 5/8" (Spliced third points)
4 shear pl. 126"x 7/16"
2'-10"
10'-6 1/2" b. to b. Ls
1"φ bent rods 2' ctrs.
Concrete
5-3/8"φ cont. rods
4"x4"xNo. 14 ga. wire mesh
Asphalt blocks
C.L. Bridge
Rock ballast
9 13/16"
9"
Waterproofing
8" perforated drain
6-3"φ fiber ducts
Concrete
Steel plate diaphragm
36"-300 lb. floorbeam 6'-7 7/8" c. to c.
15'
22'-6 1/2"
45'-1" c. to c. girders
A
15 1/2"
3/4" tap bolts
4"
9 3/16"
6"x3/8" splice pl.
1L-4"x3 3/4"x1/2"
3/8" bent pl.
3/8" pl.
4 1/2"
9 1/2"
4"x3"x1/2" L
3/4" tap bolts
2'-6"
3/8" filler
A
7/8"φ ctsk. tap bolts
Concrete
1L-5"x3 3/4"x1/2"
1-Z5-17.9 lb.
7/8" ctsk. bolts
15 1/2"
3 coats of emulsified asphalt
5/8"φ ctsk. tap bolts
3/8" pl.
3/8" fillet weld continuous
Threaded grout holes
1L-7"x3 1/4"x1/2"
3"x2 1/2"x3/8" L
Grout
7/8"φ ctsk. tap bolt
8 1/4"
14"
3/4"φ ctsk. tap bolts
3/8" fillet weld 2" long, 6" c. to c.
5 3/4"
1L-3 1/2"x3 1/4"x1/2"
13 1/2"
3/8" bent pl.
Top of 4"x3 3/4" L
Steel pl. ornamentation
Top of concrete
2 1/2"x2 1/2"x3/8" L
Varies
3/8" pl.
14"
6"
4"x3"x1/2" L
Top of cover plate
3/8" filler
Top of girder
Wire mesh
Asphalt block
Waterproofing
1/2"φ
Varies
3/8"φ
3'-11"
Fascia
4 Ls, 6"x6"x1/2"
Web 115"x3/8"
Bot. cov. 12 1/2"x3/8"
Girders
4 Ls, 8"x8"x5/8
Web 74"x7/16"
6 cover pl. 18"

FIG. 6.—TYPICAL STEEL DETAILS of some of the bridges. Heavy girders in the midtown area are of nickel steel. Note the complicated details of the steel plate ornamentation.

ing a steel plate deck, on which a shallow layer of filler concrete was placed to support membrane waterproofing protected by asphalt blocks. The stringers are spaced by vertical steel diaphragms.

Further west, but still east of the business section, the streets become wider, the grade higher and the spans longer. Most of the bridges in this area are multiple span, carried on curb or center columns. The structures are of the same general type as those to the east, except that in long spans the longitudinal girders are built-up sections. Decks are steel plates covered with concrete and waterproofing, except at Lodi St. where a reinforced-concrete deck was used in place of the steel deck. The outside girders are deeper than those inside, and have curved bottom chords to improve the appearance.

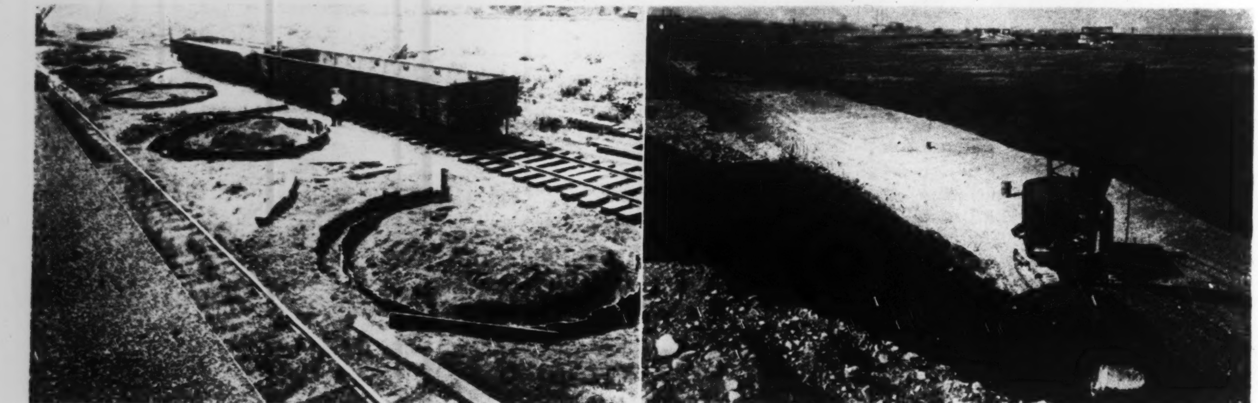
Mid-town Bridges—The five bridges crossing streets in mid-town or business section are of unusual design. Basically, they consist of two through plate girders carrying three tracks, a design dictated by a desire to save purchasing of very expensive land and buildings for additional right-of-way. Span lengths vary from 68 ft. to 109 ft. The longest girders, at Salina St., are among the heaviest ever fabricated, weighing 147 tons each. They are 10 ft. 6½ in. back to back of angles. The top flange is made up of four 8x8x1⅛-in. angles, six cover plates 24x¾ in., and six side plates, all having a section modulus of 26,900 in.^{3} The bottom flange is not quite so heavy, having a section modulus of 22,100 in.^{3} The James St. bridge girders are of the same general design, but the span is somewhat shorter.

An interesting feature of the Salina and James Sts. bridges is that all main members of the long girders are of nickel steel. Their design was based on working stresses of 27,000 lb. per sq.in.

As an architectural feature metal ornamentation has been applied to the outside faces of the girders in the midtown area. Details of this ornamentation are shown in Fig. 6. It consists of coping belts of plates and angles covering the top and bottom flanges. Panelled plates are hung over the girder stiffening angles, carrying designs worked out in strips of steel.

At the State St. and Oswego Blvd. bridges, the design of columns at the center of the street is of interest. These supports have the appearance of masonry piers, but are steel columns encased in reinforced concrete. It was necessary to use heavy steel columns because of the great concentrated weight at these points which, if carried on concrete alone, would have required

FIG. 7—SLIDING FILLS caused some trouble in soft-ground areas. Steel sheet-pile cylinders driven to hard material and filled with gravel anchored the fill toe in one section; wide blankets of gravel held the toes in place on another section.



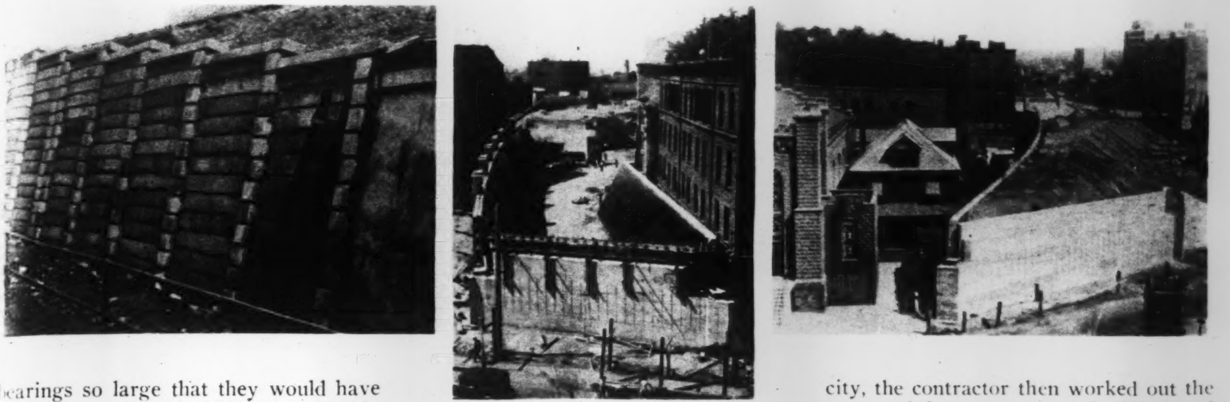


FIG. 8—RETAINING WALLS, 8,000 lin. ft. of them, were a big item in the elevation project.

bearings so large that they would have taken up too much of the street width. Even with the steel columns the restricted bearing area necessitated the use of special alloy steel expansion rollers and castings.

The floor system of these bridges is made up of rolled beams, the heaviest being 36-in. 300-lb. wide-flange sections, set transversely to span 45 ft. 1 in. between girders. On top of the floor beams is a ⅝-in. steel plate, carrying a waterproofed reinforced-concrete deck from 2½ to 9 in. thick. The tracks, 13 ft. c. to c., are laid in ballast, which is drained by half-round perforated metal pipes.

Deck Girder Bridges—The third general type of bridge, used on all crossings west of Salina St., consists of single-span deep longitudinal deck girders. Fascia girders have curved bottom chords for the sake of appearance. On the three-track bridges, twelve girders are used, set about 3 ft. 11 in. apart. Decks are of reinforced concrete, without metal floor plates, waterproofed membrane protected by asphalt blocks. The new four-span bridge over Onondaga Creek is of this design, as is also that for the industrial line crossing the creek. Street spans vary from 64½ ft. to 85 ft. 2 in.; the creek spans from 49½ ft. to 95 ft. 9 in.

Construction program

In general, construction was carried out in three steps, starting at the east end of the project: (1) excavation, pile driving and foundation work for structures; (2) building of piers and abutments and erection of steel; (3) placement of fill. As the heaviest work was in the business section, operations were concentrated there from the first. Appurtenant work, such as sewer and water line changes, progressed with the general construction.

Aggregate and Fill Material—A convenient source of material for the 1,500,000 cu.yd. of fill and 130,000 cu.yd. of concrete was found about 9½ mi. east of the center of the project. Here the contractor purchased a 62-acre level plot alongside the West Shore R.R., which contained a natural bed of well-proportioned sand and gravel 40 ft. deep, covered by only a foot or two of overburden. For excavation of the material a battery of crawler draglines from 2¼ to 3½-cu.yd. capacity were used, loading directly into 50-car trains of standard gage dump cars for the haul to the job (Fig. 5). A screening, washing and crushing plant was installed at the gravel pit for preparation of concrete aggregates. At first the draglines were able to cast directly onto a belt conveyor feeding the plant, but as the pit widened out, raw aggregates were delivered to the plant in cars. Sized aggregates were likewise hauled to the job in standard cars.

As ground water level at the gravel pit was about 15 ft. below the surface, much of the material was excavated from under water. Trains of aggregate and fill were hauled to the project by 170-ton New York Central R.R. locomotives, operated by railroad crews.

Excavation and Pile Driving—To attack the widespread job of foundation excavation and pile driving required an extremely mobile plant. This was furnished by a battery of cranes, both the locomotive and crawler type, equipped with clamshell buckets. All concrete piles were of the Western Foundation Co. type, cast in place and rammed with a spud. The encased holes for these piles were driven with heavy skid drivers using single-acting steam hammers. The timber batter piles were all driven with swinging leads hanging from a crane boom. First the tips were driven a foot or so into the ground to get a toehold, then the leads were tilted to the desired batter and the piles were driven down.

All excavated material was incorporated into the fill. Some of it was merely piled up behind abutments and retaining walls, while the remainder was hauled in trucks or cars to make ramps for later railroad fill operations, or to small pockets formed by intersecting retaining walls where it was placed in final position by clamshell.

Concrete Operations — Having determined upon production of concrete aggregates at the gravel pit east of the city, the contractor then worked out the most satisfactory system of mixing and placing. Many arrangements were considered before the final decision was made to establish a central batching plant as close to the center of gravity of concrete operations as possible, and to mix and distribute the concrete by means of truck mixers. The batcher was located just east of the passenger station area during early construction days, and later was moved two blocks east to make way for the station-area fill. Locomotive cranes charged the batcher storage bins from stockpiles or directly from cars. Bulk cement was used, being unloaded into a screw conveyor and elevator by hand scrapers.

The use of truck mixers proved ideal, for it was the most flexible arrangement of equipment to effectively cover deposition of concrete at numerous points, and the transportation time was utilized for mixing. Five 4-yd. truck mixers handled the entire concreting job. In one month a total of 18,673 cu.yd. was placed in 24 working days of 16 hr. each, an average of 778 cu.yd. per day. The highest day's yardage was 1,140.

Concrete was handled from truck to form by crane and dump bucket except, of course, in foundations where the trucks discharged directly into the hole. The buckets, 1-yd. controllable bottom dump type, were hoisted by crane to a hopper set on top of the forms. Flexible spouting conducted the concrete from the hoppers to place.

Forms, in general, were panels up to 20x23 ft. in size, used over and over again, and set up and stripped by cranes. The panels were made up of 2x8-in. studs, 24 in. c. to c., faced by waterproofed fibre board, and backed by double steel channel wales, separated by welded straps. The form bolt tie system fastened through the split wales.

Placing the fill

Placement of the 1,500,000 cu.yd. of fill within narrow, restricted working limits was, of course, the biggest construction problem. The usual way is to build a temporary trestle, from which to dump a fill for one track, and then dump and spread from this first track to the full width of fill. However, the

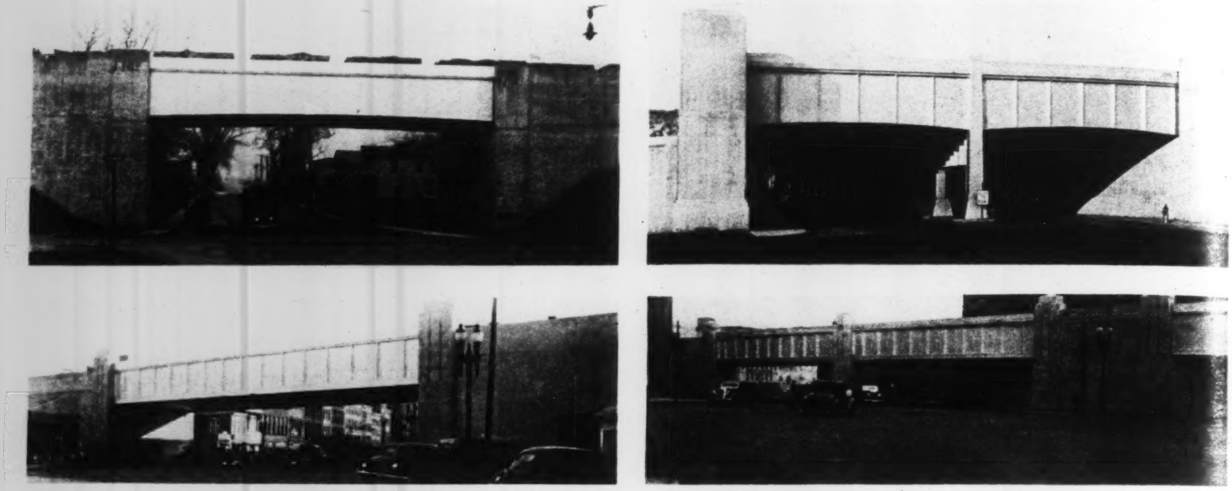


FIG. 9.—FOUR TYPICAL BRIDGES on the Syracuse track elevation project. The lower bridges are two-girder three-track structures adorned with metal plate ornamentation on the steel and cast stone covering of the piers and abutments.

contractor avoided the expense of a long trestle by working out another plan of filling that eliminated all trestle work except a few temporary street crossings. There were really three different methods of filling adopted.

In the east end of town there was room to run a construction track on the ground around one end of the abutments. On the fill side of this track a trench was excavated by a fleet of small draglines. Then entire 50-car trains of sand and gravel were dumped into the trench. As fast as the trains were dumped, the draglines scooped the material out of the trench and sidecasted it into a high ridge (Fig. 5). In this manner a narrow fill to carry one track was built for the eastern section of the job. Steel erection had been completed on the bridges in this area by the time the first fill was ready, enabling the remainder of the fill to be built by dumping and spreading from the top. The heavy road engines were kept off the fresh fill, the trains being split into five or ten-car lengths and handled by light engines owned by the contractor. A Jordan spreader was used in widening the fill.

In the central part of the project most of the fill area was between retaining walls, frequently closed in at the ends by the bridge abutments. These pockets were filled by truck, when trucks could get to the fill, or by crane and clamshell, working from trucks or cars outside the walls. A long ramp at McBride St. enabled the work trains to get on top without waiting for the easterly end of the fill to be completed, and speeded up the start of filling at the west end.

The west end of the project already contained a low fill of the West Shore R.R., which crossed several streets on low-clearance bridges. These structures were torn out and replaced by temporary trestles. The fill in this area was started by dumping from the old fill to within reach of draglines, which built up a narrow section of the full height of new fill. Once room was available for a track on top, the remainder of the fill was completed from the high level, by side dumping and spreading.

Fill stabilization

The soft ground conditions presented some interesting problems. Near the east end of the city it was necessary to stabilize the embankment at one location by driving ten cylinders of steel sheetpiling 19 ft. in diameter, spaced 38 ft. on centers and connected by arcs of steel sheetpiling. These were driven to rock 40 ft. below the surface passing through 5 ft. of coarse gravel overlying the rock. The material inside these cylinders was removed and replaced with a specially selected gravel fill. The cylinders were then capped with a concrete mat 3 ft. thick. At the westerly end of the city soft material was also encountered, but due to this material being approximately 100 ft. in depth the stabilization was accomplished by placing a blanket of gravel fill similar to the embankment material, 50 ft. wide and 12 ft. deep, adjacent to the toe of the embankment, which is 40 ft. high at this point. Both of these corrective measures are shown in Fig. 7.

Steel erection

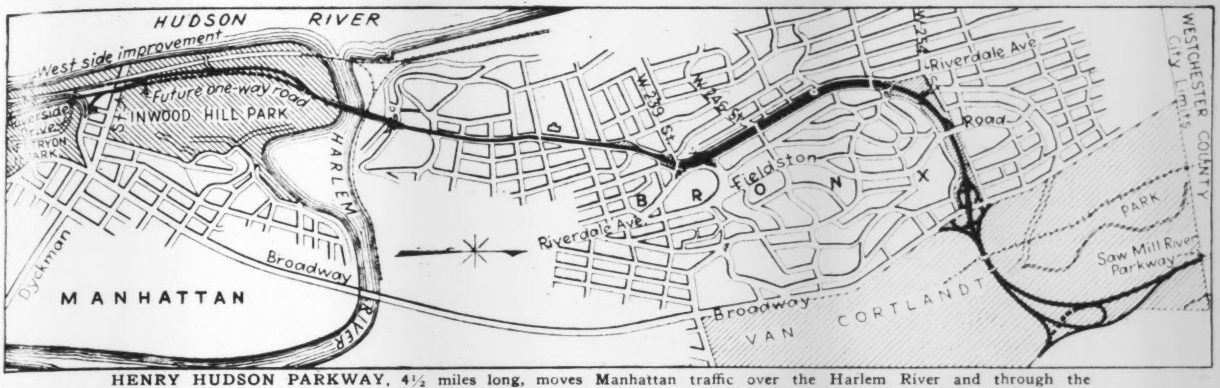
Except for the larger bridges in the central district, the steelwork was fairly light, and could be handled by cranes working on the ground. The long, heavy girders on the mid-town bridges presented an erection problem. Initially the girders were unloaded from their cars on temporary bridges over the street onto traveling towers built up from street level, the unloading to be done by A-frames. However, this scheme did not prove practicable, and the remainder were unloaded and set by two railroad wrecking cranes. A modified system of traveling towers was used in connection with the cranes.

Filling in of the floor system and completion of the steel work was done from on top with locomotive cranes. Some falsework was required for transportation and erection of the steel.

Direction

The Syracuse project was planned and carried out by the engineering department of the New York Central R.R. under the general direction of J. W. Pfau, chief engineer, and E. A. Dougherty, assistant chief engineer. Design of the various features was handled by the following: bridges, H. T. Welty, engineer of structures; buildings, J. P. Gallagher, architect; mechanical, D. B. Thompson, mechanical and electrical engineer; signals, F. B. Wiegand, signal engineer. Construction was under the direct supervision of Arch D. Duffie, assistant engineer. The Syracuse Grade Crossing Commission, a state agency, collaborated in the general design. Nelson F. Pitts, Jr., is chief engineer of the commission.

For the Walsh Construction Co., general contractor on the bridges, grading and station platforms, David Small, vice-president, was in charge, assisted by James Small, general superintendent. The American Bridge Co. fabricated and erected the steel for the bridges and the express building; B. F. Greiner was superintendent. The Western Foundation Co., Chicago, was subcontractor on the pile driving. Building contracts were as follows: station, mail and service building, Wm. M. Ballard, Inc., Syracuse; express building, Duffy Const. Co., New York; car facilities buildings, Gorsline & Swan Const. Co., Rochester, N. Y.; steel erection passenger station and mail and service building, McClintic-Marshall Co.; steel erection, car facilities building, Leach Const. Co., Rochester, N. Y.



HENRY HUDSON PARKWAY, 4½ miles long, moves Manhattan traffic over the Harlem River and through the Bronx to Westchester parkway system relieving one of the worst traffic bottlenecks in the city at the Broadway crossing of the river. The future roadway in Inwood Hill Park will connect with a future upper deck on the river bridge.

New York City Opens a Toll Parkway

THE OPENING on Dec. 12 of the Henry Hudson Parkway in New York City marked a significant step in the building of a 17-mile express highway along the Hudson River waterfront from the lower end of Manhattan Island to the city limits at the north side of the Bronx. The new link, as the map shows, extends Riverside Drive, near the north boundary of Manhattan Island, through Inwood Hill Park, across the Harlem River (on an 800-ft. hingeless steel arch span described in ENR Aug. 13, 1936, p. 232, and Nov. 12, 1936, p. 669) through the streets of the Bronx and into and through Van Cortlandt Park to a connection with the Sawmill River Parkway in Westchester County.

For the first two miles of its length, the parkway is a toll road (10 cents per vehicle) and, including the Harlem River arch, was built by the Henry Hudson Parkway Authority, an agency of the city created by the state legislature with the New York City park commissioner, Robert Moses, as the sole member. The Authority's privately subscribed bond issue of $3,100,000 provided funds for the work. The northern half of the new parkway is the work of the New York state department of public works using $2,750,000 of state and federal highway funds. The city provided the right-of-way.

Nine grade separation structures are included in the state work, and four in that built by the Authority. Except for the bridges illustrated most of the other structures are of concrete rigid frame type and carry the cross streets.

Although opened to traffic, some work remains to be completed.

The engineering work of the Henry Hudson Parkway Authority was handled by the firm of Madigan-Hyland of which E. H. Praeger is chief engineer. Consulting engineers on the design were Robinson & Steinman and Waddell & Hardesty. For the New York state department of public works Frederick Stuart Greene is superintendent, Arthur W. Brandt, commissioner of highways and Joseph J. Darcy, district engineer. The park work was under Allyn R. Jennings, general superintendent and William H. Latham, park engineer.

NORTH from the Harlem River Bridge, where tolls are collected, two 32-ft. separated roadways carry the motorist to the city line. On the bridge and south of it is a single 40-ft. roadway.
—Aerial Explorations Photo.

OVER DYCKMAN ST. the parkway is carried on a four-rib open-spandrel concrete arch of 120-ft. span

STEEL RIGID FRAME bridge of 82-ft. span carries parkway over Broadway at entrance to Van Cortlandt Park

The Fallacy of Tax Limitation

Two decades of experience have shown many faults and no advantages—End result is merely a shift of tax burden from one group to another since public services must be paid for.

THE NEGATIVE RESULTS *from all attempts to place a limit on taxes by statute were placed in bold relief before the recent convention in Augusta, Ga., of the Investment Bankers Association of America, by C. A. Dykstra, city manager of Cincinnati. Tax reform has nothing to do with tax limitation which is merely a shifting of the tax burden from one group to another, said Mr. Dykstra. His address, constituting a penetrating analysis of a dangerous trend, is reproduced here practically in full.*

—EDITOR

SOME twenty years ago an Ohio governor sought to solve the tax problem by prohibition beyond a limit. It was a vain solution, yet the story has been repeated in state after state within the last decade. By this time ten states—Georgia, Illinois, Indiana, Michigan, New Mexico, Oklahoma, Ohio, Rhode Island, Washington, and West Virginia—have established overall limits on property taxes, and forty states have some form of municipal property tax limits for certain purposes.

Advantages not proved

To date, all that has been accomplished by the system of tax limitation has been some tax relief for certain real estate interests. Nowhere has there been any outstanding success in tax reform. Tax limitation advocates have found no factual basis for their arguments which rest on the following assumptions:

(1) *Assessments can be brought to a 100 per cent basis.* The evidence tends to prove the exact opposite, and the states which have tax limitations still have competitive under-valuation. The real estate forces which fight first for limitation retire to a second line of defense and immediately begin a campaign for reduced assessment.

(2) *Reorganization of the tax structure will be forced.* This is a case of having the cart before the horse. What we need is to develop a revenue raising program, and once that is done it would probably not be necessary to consider limitation at all.

(3) *Taxation of intangibles at similar rates will be brought about.* This assumption has not yet been proved.

By C. A. Dykstra
City Manager, Cincinnati, Ohio

(4) *Public expenditures will be curtailed.* It has not worked out that way. Limitation is not a substitute for proper budgeting, and has proved to be merely a means of accumulating debts. Under the Smith law in Ohio, a bond burden of deficiencies of $100,000,000 was created, and from 1912 to 1922 taxes in the counties and cities increased 96 per cent.

(5) *All local finance considerations will be reduced to a single situation and rule.* It should be obvious that fiscal plans must be adapted to government needs rather than the other way around. The assumption that limitation will simplify governmental structure is not borne out by the facts. Actually, one result of limitation has been to increase the number of local governments through the development of authorities to escape debt limitation.

In Ohio the average real estate taxpayer, using a $3,000 value as a base, saved $12 by virtue of real estate tax limitation but the 3 per cent sales tax (adopted to replace the lost revenue) cost him anywhere from $20 to $40. The tax limitation may have helped the larger owners of real estate and the public utility organizations but it has made the small taxpayer worse off than before.

More fundamental approach needed

The whole problem of government expense and government simplification is being attacked at the wrong end. In arranging any tax program the proper place to begin is in a determination of what it is that we want governmental authority to do. Having determined this, we should find out what is the legitimate cost of such services. The next step is to decide whether these services shall be paid for on a service basis or on an overall basis. At this point it must be remembered that the cost of billing and collecting for all individual services is very expensive and that we can probably cut overhead enormously by the device of an overall collection. The next thing to do is to set up a tax system that will bring in the necessary revenues.

Meanwhile, we should be in the business of simplifying governmental agencies. Instead we are multiplying them by tempting local authorities to expand their opportunities for creating debts to make up deficiencies.

Another problem to be recognized relates to the part taxes play in the operation of business. Above all it should be appreciated that the great bulk of tax revenues are spent for wages and commodities in the same way that private incomes are spent. Even public debt is not so very different from private debt. These debts we owe to ourselves, and insofar as they are paid they are paid by the ultimate consumer and the ultimate taxpayer, who is one and the same individual. Private debts may easily be transferred into the realm of public debts, and by the same token a public debt is easily converted into a private debt. This is exactly what happens when a municipality purchases an electric light plant from an operating concern, or when, for instance, a private company purchases a public plant from the community.

Public costs bound to increase

There are other fundamental considerations that we cannot neglect. We must recognize, for instance, that governmental expenditures cannot be fixed for future years because of changing conditions and changing attitudes toward the public services. More and more we tend to raise private income by the device of adding to the social income of our people through the public services. If there is one thing clear in 150 years of American experience, it is that public expenditures continue to increase primarily for the reason that the people insist on doing certain things as communities that they used to do for themselves. In spite of this American experience, no American political campaign fails to produce the candidates for office who promise to cut public expenditures if only the electorate will mark the ballot in the right way. Many times these promisors have been elected, but public expense and public debt have continued to mount none the less.

Recognizing the fact, then, that we are going to have more and more public services and that we need to find the necessary revenues to support such services, we must make decisions on the question of whether we shall pay for services as we go or run the chance of funding deficiencies. Certainly nothing is gained by making it impossible for government to defray current operating costs out of revenues currently collected. Moreover, we must remember that the curtailment of desirable and necessary services actually destroys the incentive for the payment of taxes.

From our experience to date it is probably fair to say that instead of improving fiscal practices, legislation of the limitation type seems to make them worse, and that tax limitation is an unintelligent and ineffective method of accomplishing desirable results. It is negative and selfish rather than constructive and in the social interest. If the energy which we have devoted to tax limitation had been devoted to an intelligent effort to improve state and local fiscal systems as well as taxing systems, we would have arrived somewhere by this time. Those states which have dealt more fundamentally with this problem have made more progress in intelligent tax reform. Every study of tax limitation proposals indicates not only its foolishness but its futility.

It is apparent that the demand for tax limitation comes from one pressure group, and that the purpose of it is the shifting of public costs. Success for one group is bound to mean competition between groups for the shifting of taxes. Pushed to the absurdity for the sake of the argument, we may predict that in the race for exemptions we may look forward to the time when by constitutional amendment we shall abolish all taxes, and at the same time—perhaps on the same voting day—add still new government services to those which even now cry out for proper financing.

Tax limitations have been read into our fundamental law by some of the same interests, who, through the device of special assessments now gone sour, were in part responsible for saddling vast debts upon our local governments. In many places it is this same assessment debt which is "the staggering burden" under which real estate groans. It was this kind of debt finally saddled on the general taxpayer that broke the camel's back in the last few years. And yet the tax load is not lightened: it is merely shifted to those less able to pay.

In no city has the tax limitation been a protection to the taxpayer. Sometimes it is merely an excuse to cover up inefficiency, or worse. The apologist for a wasteful regime clamors that it is a lack of money which prevents the giving of proper service. On the other hand, the tax limit may even lend color to false pretenses of economy and achievement.

The quality and economy of a city government depend upon the integrity and competence of its officers and servants, and upon the spirit and understanding of its inhabitants. Given these characteristics, and given a form and tradition of governmental responsibility to the people, a city can determine for itself what governmental services are worth their cost, and what taxes are necessary to provide such services.

English Administrative Practice In Stream Pollution Control

By **Willem Rudolfs,**
Chief N. J. Sewage Experiment Station, New Brunswick, N. J.

STREAM POLLUTION *abatement is publicly recognized today as one of our major national problems. Before any real progress can be made in applying corrective measures on a large scale, however, a sound plan of administrative, legal and financial procedure must be developed, as stated in our issue of Dec. 10, p. 837. In this connection it is of value to review what has been done in England where stream-cleansing programs and pollution-prevention legislation have long been applied with effective results. In the following article, based on information obtained in a recent trip abroad, Dr. Rudolfs outlines British experience and practice.* —EDITOR.

INTEREST in stream pollution abatement has been progressing rapidly during the last few years. Questions covering water conservation are raised by engineers, municipal officials and farmers, and there is an increasingly popular demand that streams be cleansed for recreational purposes. Discussions of the best administrative methods of pollution prevention are heard at public gatherings and in committee meetings. Frequently the systems used in Germany are cited, but less often the methods followed in England. In the experiences of the latter country, however, we find many useful examples of practice that have been developed through years of trial.

It is generally recognized in England that to secure the proper administration of the laws pertaining to the pollution of rivers it is desirable that the whole area drained by a river and its tributaries be placed under the control of one authority. For that reason the formation of rivers boards has been repeatedly urged by royal commissions and other bodies. Existing legislation, however, gives broad powers of control to various agencies.

Existing legislation

The most important laws governing stream pollution are: the Rivers Pollution Prevention Act of 1876; the Salmon and Fresh Water Fisheries Act of 1923; the Land Drainage Act of 1930; and the recent Drainage of Trade Premises Bill of July 1936. Under the Rivers Pollution Act the administration of the law was entrusted to the various sanitary authorities then existing. These consisted of municipal corporations, improvement commissioners and local boards in urban areas, and guardians of the poor in rural areas. For obvious reasons those authorities did not display any great zeal in the execution of their duties dealing with pollution. They not only lacked the benefit of technical assistance, but in many cases were themselves offenders in the discharge of sewage and waste. Even if the members of one group were inclined to take action they would be discouraged to find that other authorities above and below them were content to do nothing. Since a river flowed through many districts on its course from source to sea, strong united action was needed to achieve any real results. Of considerable importance was the fact that local influence was generally against enforcement of the law. Manufacturers in an active district would complain that they were penalized in competition with those who were established in a less progressive locality and consequently very little was accomplished.

The local government act of 1888 established county councils, thus increasing the areas under jurisdiction. Many county councils exercised their powers from time to time, but since the extent of their authority was by no means coterminous with drainage areas, the results achieved were purely local.

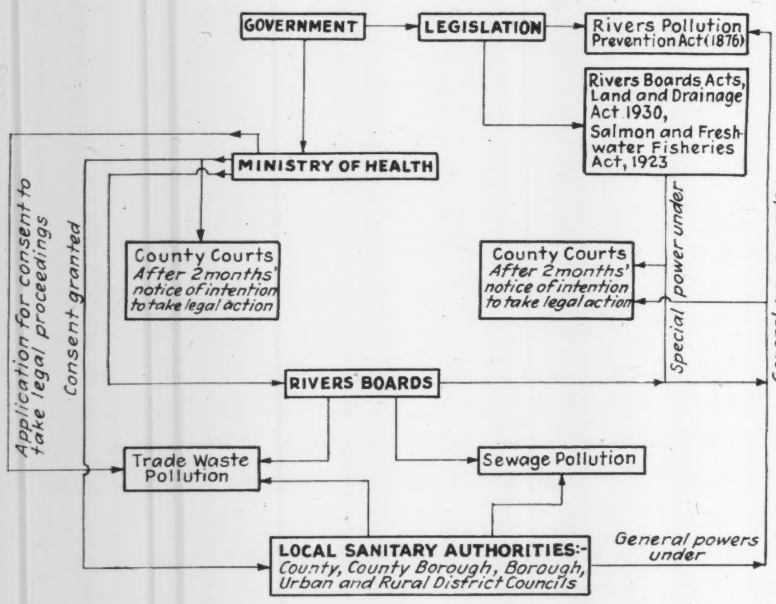
Under the Salmon and Freshwater Fisheries Act a board can be organized for the protection of the fish life in streams of a catchment area where pollution has already injured or may cause prospective injury to fish. Some of these boards are very active in places where county councils have taken no interest. They obtain funds from licenses sold to anglers. An angler must pay a fee of about 25 cents if he wishes to catch coarse fish, about 65 cents for trout and about five dollars for salmon. These boards are more important in connection with keeping clean streams clean, than in the restoration of dirty streams. If there are no fish to be caught there is no income and consequently little activity.

The Land Drainage Act divides the land into catchment areas for the purpose of land drainage administration. The personnel of the catchment area boards includes representatives from county councils. communities, internal drainage boards and the Ministry of Agriculture. A section in this act grants certain powers relative to pollution abatement. The Ministry of Health is also empowered to constitute a joint committee with these boards to act under the laws of 1876. The possibility of combining catchment boards with water pollution boards is now being studied.

The Drainage of Trade Premises Bill of 1936 was introduced as a means whereby regulatory conditions could be made more uniform throughout the country. The powers granted by this legislation are very broad. Any pollution by sewage—and sewage is considered as constituting any foreign matter (either domestic or trade wastes) that may change the pristine purity of the stream—can be prevented. While minimum standards of purity are established by the Ministry of Health, dependent on general conditions in the entire river basin, local authorities may increase the requirements.

Boards now active

At present there are six rivers boards in operation, some of which function under special acts and others under the general law. These include: (1) The West Riding of Yorkshire Rivers Board, which has been in operation for 43 years and has about 450 sewage treatment plants under its jurisdiction; (2) Mersey and Inwell (Manchester) Joint Commission, (3) Ribble Joint Commission (general act), (4) Lee Conservancy, (5) Thames Conservancy, which has the most drastic powers and requirements; and (6) River Dee Joint Commission, the most recent one to be formed.


GOVERNMENT
LEGISLATION
Rivers Pollution Prevention Act (1876)
Rivers Boards Acts, Land and Drainage Act 1930, Salmon and Fresh-water Fisheries Act, 1923
MINISTRY OF HEALTH
Application for consent to take legal proceedings
Consent granted
County Courts After 2 months' notice of intention to take legal action
County Courts After 2 months' notice of intention to take legal action
Special power under
General power under
RIVERS BOARDS
Trade Waste Pollution
Sewage Pollution
LOCAL SANITARY AUTHORITIES:- County, County Borough, Borough, Urban and Rural District Councils
General powers under

ADMINISTRATION of pollution abatement in England showing the coordination of various governmental agencies. The Ministry of Health administers laws, the rivers boards are police agencies and the local authorities build and operate treatment plants. The latter also have legislative powers to control pollution but they take no action where rivers boards have been established.

Local districts, such as the West Middlesex Drainage District in which the new Mogden (London) plant is located, are formed by county councils to take care of portions of drainage areas easily combined for centralized treatment of sewage and the elimination of a number of small disposal plants. A district such as this is operated under the general jurisdiction of a rivers board.

The organization and administration of a rivers board can probably best be indicated by taking as an example the West Riding of Yorkshire board. This agency, formed in 1893 under the local government Act of 1888, and constituted by the West Riding of Yorkshire Rivers Act of 1894, consists of thirty representatives elected by the counties, cities and boroughs in the district. The board, functioning mainly as a policy agency with powers guaranteed by the county courts, compels offenders to build disposal works, and it also supervises the operation of these plants. When local sanitary authorities such as county, borough, or rural district councils (who in themselves have wide powers under the Rivers Pollution Prevention Act of 1876, but are content to have the rivers boards take action) wish to build disposal works, the plans and specifications are submitted to the rivers board. The board maintains its own laboratory, where a staff not only analyzes samples sent in by the district inspectors, but also undertakes chemical and biological research in methods of treatment, stream gaging, and swimming pool supervision. All such information is made available to manufacturers and local authorities.

In the early days of its existence the board's policy concerning trade wastes disposal requirements was strongly opposed by the "Manufacturers and Mill Owner Association." After several cases were tried in the courts, however, in which the board was sustained, a more cooperative attitude was shown. As a general rule trade wastes are treated together with domestic sewage rather than in separate purification plants. By discouraging the multiplication of small plants in favor of centralized disposal works, treatment measures can be applied more effectively and at less cost.

The chairman of the board stated (40th Annual Report) that "the board has protected the cleaner streams against pollution and abuse, so that they are still pleasant to the eye and useful to the community as sources of water supply for man and beast, for industry as well as sanitation, for recreation and sport. . . . The board has definitely improved the condition of streams which were grossly polluted. . . . As a result of this improvement, rivers which one time were too foul to be used for any purpose whatever are now available for many manufacturing processes."

The cost of operating rivers boards varies somewhat. In the case of the West Riding Board, which is typical, the cost has been for a number of years about one-seventh of a penny in the pound (or about 69 cents per $1,000) on the assessed valuation of the West Riding geographical area; the population of the district is about 3,365,000, the ratable land value about 18,134,000 pounds, and the expenditure of the board is in the neighborhood of 10,000 pounds.

Loans for all sewerage and sewage treatment works can be raised by local authorities only after they have obtained the sanction of the Ministry of Health. Applications for loans must be accompanied by plans and specifications. Local public inquiries, presided over by a Ministry of Health engineering inspector, are then held to permit interested parties to object or comment on the project. By having control of the loan sanctions the Ministry of Health is thus indirectly able to ensure that projects sponsored by local authorities are carried out on an engineering basis of economic design and construction.

The coordination of the rivers boards with other authorities is shown in the accompanying schematic chart (Fig. 1). While this may at first glance appear to be rather complicated, in effect the relationship simply provides that: (1) The rivers boards are responsible for the abatement of pollution; (2) The Ministry of Health ensures sound engineering; and (3) The local authorities take care of the construction and operation. Since each local authority is represented on the rivers board or has a voice in the stream cleansing program the objective of cooperative action can be more easily realized.

Centralized Sewage Disposal For Greater London Area

The Mogden purification works provides sewage treatment for 16 communities formerly served by 28 disposal plants. Design features two-stage systems of sedimentation and sludge digestion.

THE MOGDEN SEWAGE purification works serving 16 municipalities in the West Middlesex district of the Greater London area in England, formally placed into operation on Oct. 23, provides disposal facilities that were previously handled by 28 separate treatment plants. This vast scheme of centralized sewage disposal, described in *The Surveyor* of Oct. 30, included the construction of 67 miles of main interceptor sewer, an activated sludge type treatment plant, sludge disposal works 7 miles from Mogden, and a power plant with diesel oil engines that are convertible for operation on sludge gas.

The total cost of the undertaking was about $27,100,000. Half of this was covered by a government grant and the remainder will be paid for by a tax of about $2.40 per $100 levied on the district. The district has a total area of 160 sq.mi. and a present population of over 1,000,000; the rate of increase is 60,000 people per year. Sewers have been designed for a population of 2,000,000 and the disposal works are adequate to serve 1,250,000 people.

Sewerage features

In the design of the sewer system the daily dry weather flow was estimated at 48 gal. per capita and the maximum rate of flow in wet weather was placed at 288 gal. In this basis provision was made for discharging 690 m.g.d. of sewage at the disposal works. About three-quarters of this volume is conveyed by gravity and the remainder derived from the low-lying Thames valley, is lifted about 50 ft. at the purification plant and discharged with the incoming high level sewage.

The total length of main intercepting sewers, ranging in diameter from 21 in. to 12 ft. 9 in., is 67 miles; in addition, three miles of connecting sewers of smaller diameter have also been constructed. Of the total length, about 21 miles have been built in open trench, and the remaining 49 miles in tunnel.

Sewers up to 3 ft. 9 in. in diameter are of aluminous cement concrete pipe or of cast iron. Sewers of 4 ft. diameter and over in open trench have been constructed of concrete, reinforced where necessary, and lined with brickwork; in tunnels the sewer sections consist of 2, 3 or 4-ring brickwork, cast-iron segments lined with brickwork or concrete segments lined with brickwork.

The purified effluent leaving the Mogden works is discharged into twin culverts, 11 ft. diameter, which have been driven to the Thames at a depth of about 50 ft. These tunnels terminate at four penstock control chambers, each 22 ft. in diameter. From each of these chambers three 6 ft. diameter outlets have been driven (making twelve outlets in all) under the river channel, to terminate in vertical outlet shafts constructed inside steel caissons sunk into the river bed. This arrangement insures a diffusion of the effluent into the main stream of the river over a length of about 400 yd.

Complete treatment will be given to all volumes of sewage up to a rate of three times the dry weather flow; partial treatment, by sedimentation storm water tanks will be provided for all flows in excess of this rate. On entering the plant, the sewage first passes through a screen and grit removal structure. This is divided into six independent units, each with a maximum capacity of about 104 m.g.d., and which are brought into operation in accordance with the rate of flow by means of automatically controlled hydraulic penstocks. Each unit is equipped, first, with a coarse screen rack consisting of bars spaced 4 in. apart, followed by a second screen with a bar spacing of ¾ in. The screenings are removed mechanically and then transported by belt conveyor to a disintegrator, where they are macerated and passed back into the sewage on the upstream side of the screens.

A standing wave venturi flume is installed at the outlet of each grit chamber. This not only records the flow but also controls the sewage level in the chamber so that by means of a special cross-section given to the 90 ft. channel a velocity of 1-ft. per sec. is maintained at all flows. Grit is removed by suction dredging, washed, and then pumped to settling ponds for disposal.

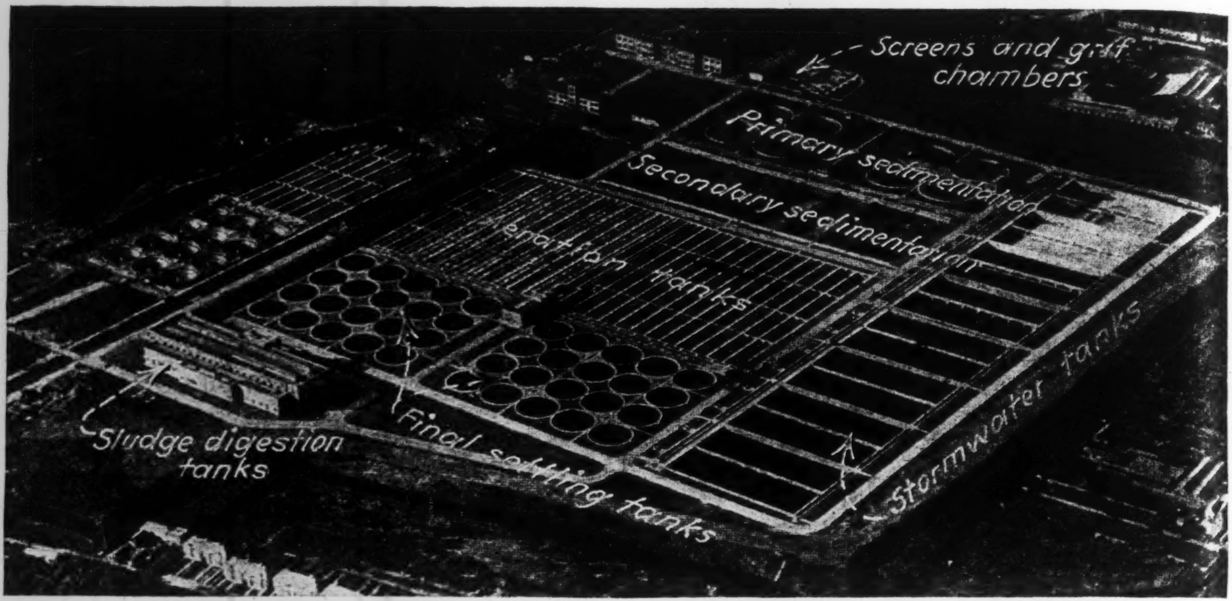
After leaving the grit chambers, the sewage passes through the storm water overflow chamber, where any water in excess of three times the dry weather flow is diverted into culverts leading to eight storm water tanks. These tanks are 230 ft. long by 150 ft. wide and 12 ft. deep. Their total capacity is 24 m.g.

Two-stage sedimentation

Sedimentation of all sewage except that entering the storm water tanks is effected in two stages. The primary tanks, eight in number, have a total capacity of 5.4 m.g. They are circular in plan, 95 ft. in diameter, 12 ft. average depth, and are provided with a central inlet and peripheral weir. The sludge deposited on the sloping floor is scraped to a central well by means of a revolving mechanism. The secondary sedimentation tanks are of the rectangular type. There are four of these, each 200 ft. long by 150 ft. wide, and 12 ft. deep; their total capacity is 10.8 m.g. A Mieder type of straightline scraper is used for removing sludge. This mechanism is made to serve a number of tanks by the use of a transporter carriage.

Activated sludge treatment

After sedimentation, the clarified liquor passes to the main process of purification in the aeration tanks, which have a gross capacity of 24 m.g. This plant is divided into two batteries each containing six units. Each unit consists of four channels, 400 ft. in length, 15 ft. in width, and 12 ft. in depth, equipped with compressed air diffusers. One battery is arranged to operate on the spiral flow principle, with two rows



Courtesy *The Surveyor.*

SYMMETRICAL and compact in layout the Mogden purification works is England's newest sewage disposal plant.

of 8 in. diffusers installed on one side of each channel, while the other battery is arranged on the longitudinal ridge and furrow principle with three rows of 6 in. diffusers spaced at 5 ft. centers.

For final sedimentation after aeration, 40 tanks, each with a diameter of 60 ft., have been provided. Their total capacity is 12 m.g. so that a maximum rate of upward flow of 7.5 ft. per hr. will not be exceeded.

Sludge is removed by a rotating ring-type mechanism, and discharged at the bottom of the tank under hydrostatic head to the return sludge pumping station. Provision has been made for returning any proportion of activated sludge from 15 to 50 per cent of the dry weather flow. Surplus activated sludge is pumped back into the main sewage flow at the inlet to the primary sedimentation tank, or it can be delivered to the digestion tanks directly.

Sludge treatment and disposal

The sludge obtained from the primary, secondary, and storm water tanks is pumped to two thickening tanks, 35 ft. in diameter, and 20 ft. in depth before being passed on for the first stage of treatment in the digestion tanks. There are 12 circular digestion tanks, each 70 ft. in diameter, having a total capacity of 12 m.g. The sludge receives an initial period of digestion, after which it is pumped through a rising main, 7 mi. long, to the Perry Oaks works for final digestion and disposal.

The sludge pumping main from the Mogden works to Perry Oaks consists of 12 in. cast-iron pipes constructed in duplicate for the entire distance. The sludge arriving at Perry Oaks is delivered into a battery of ten circular tanks, each 100 ft. in diameter, with a total capacity of 18 m.g. This capacity is sufficient to meet digestion requirements, and in addition will give adequate storage for meeting the seasonal fluctuation in the drying of the final product. About 50 acres of sand drying beds have been provided. The drainage system under the beds is connected to the main intercepting sewer so that all drainage can be returned to the Mogden works for treatment with the main flow of sewage. In order to minimize the contamination of subsoil water in the vicinity of the drying beds, the entire site was circled with a wall of puddle clay carried down from the ground surface to the underlying impervious strata.

At present eleven diesel oil-engines with a total power capacity of 6,750 b.hp. have been installed, and ten of these are convertible for operation on sludge gas.

For supplying air to the aeration tanks, six of the convertible engines are coupled to turboblowers, each capable of compressing 12,500 cu.ft. of free air per minute to a pressure of 7 lb. per sq.in. The remaining four convertible engines are direct-coupled to electrical generators producing d.c. current for plant operation.

The volume of gas produced at the primary digestion plant will be about 800,000 cu.ft. per day. The use of this gas for power will effect an annual saving estimated at about $100,000.

The construction of the Mogden purification plant and appurtenant works was undertaken by the West Middlesex Drainage Committee, Major Sir William Prescott, chairman. The consulting engineers for the project were J. D. and D. M. Watson, of Westminster.

Cooling Hot Well Water For Domestic Consumption

ARTESIAN well water with a temperature of 110 deg. F. is being cooled to 80 deg. F. by an evaporation system at Riverside, Calif., so that it can be used for municipal supply purposes. The well, 1,000 ft. in depth and 20 in. in diameter, tapped an underground stream of hot water when it was drilled in 1930. When this water was turned into the mains so many complaints arose that the city was obliged to discontinue its use, according to an article in the *F. & M. News,* issued by Fairbanks, Morse & Company of Chicago.

For the last six years the municipality had an arrangement with one of the irrigation companies, whereby the warm artesian water from the city well was used for irrigation and the irrigation company supplied cool water from its well to the city. This arrangement was not entirely satisfactory and several plans were considered for cooling the water economically. The system finally adopted consists of coils, over a basin, through which the water passes to be cooled. A film of water passing over the coils cools them by evaporation. Cooling water is delivered through headers to specially designed troughs, which distribute the water evenly over the coils. Through this arrangement, the temperature of water going into the main is reduced by about 30 deg. F.

This artesian well has a flow of 1,800 gal. per min.

Curing Rooms and Cold Tests For Better Concrete

Illinois highway laboratory presents advanced practice in equipment for curing concrete and for frost tests of road materials

By V. L. Glover
Engineer of Materials, Illinois Division of Highways, Springfield, Ill.

IN REACHING OUT *for closer design control of pavement concrete, state highway department laboratories have turned to studies of composition and durability. The variety of temperature, moisture and load stresses to which concrete pavement is subjected is exceptional among concrete structures. In its long relation of detail, the article indicates, more clearly perhaps than is possible in any other way, the vision that is inspiring the half a hundred federal and state highway laboratories that are working out a new science of roadbuilding materials and their use for the service of highway transport.* —EDITOR.

THE FREEZING and thawing test is one of the most valuable of those applied to highway materials. Satisfactory equipment for making the test, however, has been lacking, although many individual designs, some more or less makeshift in character, are in use. Most of the available equipment is of small capacity and lacks accurate temperature control. Another vital problem in road laboratory work is the satisfactory curing of concrete specimens. There must be accurate control of the temperature of the air surrounding the specimens, and a sufficient quantity of water must be provided to cause the chemical combination of the ingredients of the cement. Temperature control of the curing room during seasonal changes has been generally lacking; the water required is usually provided by means of pressure sprays of some sort in the room itself.

During the preparation of the plans for the new materials laboratory for the Illinois Division of Highways, both the freezing and thawing and the curing room equipment were given special study to overcome previous deficiencies. Installation of the two units was made during June 1935, and both have been operating continuously and successfully since.

The general layout of the new curing and cold rooms and of the control room which serves both is shown by Fig. 1. These rooms are located between the concrete and physical laboratories; the entrance doors to each room open into a corridor connecting the laboratories. Each room has one outside brick wall 12 in. thick; the remaining walls are wholly inside the building. The wing of the building in which the rooms are located is one story high, and the roof consists of a 5½-in. reinforced-concrete slab, 1 in. of celotex, and three layers of tarred roofing paper and gravel.

The curing room has a floor area of 215 sq. ft. and a gross capacity of 2,504 cu. ft. It is insulated with one layer of 2-in. cork on the three 8-in. interior brick walls, one layer of 3-in. cork on the 12-in. outside brick wall, two layers of 2-in. cork on the ceiling, and one layer of 2-in. cork on all doors. A coating of bituminous mastic material is placed over the cork, and the surface is given two coats of aluminum paint.

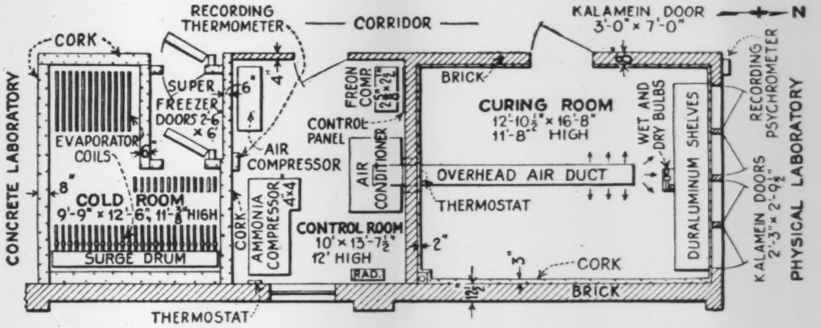


FIG. 1—COLD AND CURING ROOMS are separated by a control room in which are the refrigeration, the air-conditioning and all control and recording devices.

The doors are copper clad. In addition to the main entrance door, there are four small reach-in doors, each 27 x 33½ in., through which small specimens may be placed on and removed from the shelves of a duraluminum rack without entering the room. The duraluminum rack (Fig. 5) supports forty 2-ft. square removable duraluminum shelves, ten of which are served by each reach-in door.

Details of the cold room

The extreme inside dimensions of the cold room are shown by Fig. 1; the area, exclusive of the entrance vestibule, is 92 sq. ft. The three interior walls are constructed of two 4-in. layers of cork, the outside surface of which is covered with a coat of cement plaster ¾ in. thick. The exterior (east) wall is 12 in. thick and is constructed of brick, insulated with two 4-in. layers of cork. The inside of the walls is finished with bituminous mastic material ¼ in. thick, placed after construction and painted with two coats of aluminum paint. The vestibule walls are constructed of two 3-in. layers of cork. The ceiling is insulated with two 4-in. layers of cork, finished and painted in the same manner as the walls. The floor has a total thickness of 15 in., consisting of a layer of reinforced concrete 4 in. thick, two layers of cork each 4 in. thick, and a top layer of reinforced-concrete 3 in. thick. The two refrigerator doors are supported by a structural steel frame bolted to the floor and ceiling.

Conditioned-air curing

The design of the curing room departs radically from general practice. It is based upon the assumption that the mixing water present in fresh concrete is sufficient to produce chemical combination of the ingredients of the cement provided this water can be held intact. If, therefore, the relative humidity of the air can be held sufficiently high so that the air will not take up additional moisture, little or no water will escape from the specimens.

To produce and maintain these curing conditions, it was necessary to provide accurate temperature control and a high relative humidity. It was essential that the quality of conditioned air supplied be large enough to produce the results desired and that the velocity of this air should be kept within certain limits, that is, high enough to change the air frequently and low enough to prevent evaporation of moisture from the specimens being cured. The required conditions of operation were obtained by the use of specially designed equipment.

The air in the curing room is maintained at a temperature of 70 deg. F. plus or minus 1 deg. F. and at a relative humidity above 90 per cent by means of equipment (Fig. 2) located in the control room. The humidifying equipment is of the floor-spray top-outlet type, 28 in. wide, 25 in. deep, and 7 ft. 2 in. high, made from $\frac{3}{16}$-in. galvanized steel plate insulated from the floor with 2 in. of cork. The unit

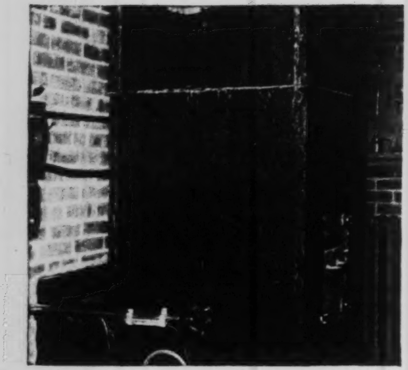


FIG. 2 — HUMIDIFYING and temperature control unit discharging into overhead duct in the curing room keeps air at 70 deg. and at a relative humidity above 90; note that all air conditioning is done outside the curing room.

is insulated on the outside with 1 in. of cork covered with bituminous mastic.

The inside of the unit is equipped with six water sprays, four 500-watt electric strip heaters, auxiliary steam coils, cooling coils, eliminator plates, a water storage tank, and an air circulating fan operated by a ¾ hp. motor, the latter being located on the top of the unit. The bottom of the unit serves as a tank to hold water for circulation through the sprays. A float valve connected to a water line automatically maintains the water in this tank at a constant level. Water is circulated from the storage tank through the sprays by means of a pump located outside the unit. This pump has a capacity of 15 gal. per minute and is operated by a ½-hp. motor.

A 1-ton water-cooled refrigerating unit equipped with direct-expansion copper coils and operated by a 1½-hp. electric motor is used for cooling purposes. This unit develops ample refrigeration to maintain the required temperature and to provide necessary dehumidification under all conditions of operation. The cooling coils are located between the sprays and the water tank.

The steam coils and electric heaters are each able to produce and maintain the required temperature in the curing room. These heating units are arranged to operate independently of each other, the electric heaters being for use only when steam is not available. The steam coils are connected to the low-pressure heating system of the building and are equipped with a motor-driven steam valve actuated by the curing-room thermostat. The electric strip heaters are also controlled by the same thermostat. A manually-operated double-throw switch in the thermostat circuit permits the use of either steam or electric heat. With this exception, the heat control is entirely automatic.

Air is carried from the temperature and humidity control devices to the curing room through a 10x15 in. supply duct, (Fig. 1) made from 24-oz. copper, suspended from the ceiling. This duct, the end of which is closed, extends 15 ft. into the curing room and has a vertical clearance of 9 ft. above the floor. It has an adjustable cover designed to permit a wide range in the velocity of the air entering the room, the velocity being regulated by raising or lowering the cover. This unit is adjusted so that the velocity of the circulating air as it leaves the duct and enters the moist room is about 500 ft. per min. The air returns to the air conditioner through a duct (Fig. 4) located near the floor. This duct does not extend into the moist room.

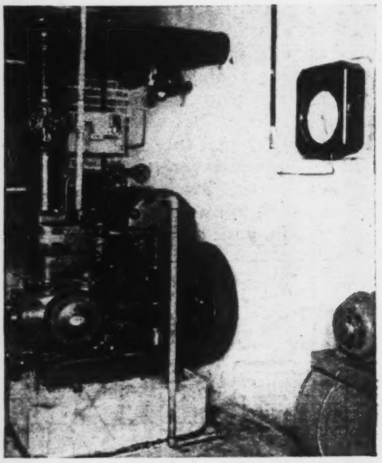


FIG. 3 — REFRIGERATION UNIT which supplies controlled freezing temperatures to cold room; recording thermometer is shown on the wall.

To obtain uniform distribution of the air and to prevent a large proportion of it from being forced out near the outer end of the duct, an adjustable baffle is located about midway in the duct. This is set to give a fairly-even flow of air along the entire length of the duct. This baffle also serves to prevent an excessive amount of moisture from entering the room, and any excess which does accumulate is removed by a drain pan connected to the sewer system.

The air is humidified by six sprays operating continuously within the unit and by two auxiliary sprays in the duct. No attempt is made to control the humidity except to provide sufficient spray capacity to maintain a relative humidity of at least 90 per cent. During periods when no heat is required, it is necessary to operate the auxiliary sprays only when the air is being cooled by the refrigerating unit. If heat is required during extremely cold weather, it may be necessary to operate the auxiliary sprays continuously to provide the necessary humidity. To date, however, with steam heat throughout the entire building, a radiator in the control room, and with outside air temperatures as low as 16 deg. F., no additional heat, either steam or electric, has been needed to maintain the required temperature in the curing room.

The air temperature is maintained at 70 deg. F. plus or minus 1 deg. F. by an air-operated thermostat which controls the operation of two magnetic switches, one operating the refrigerating compressor switch, the other the relay switch which controls the heat.

A daily record of the temperature and relative humidity in the curing room is made with a 2-pen differential-distance-type, mercury-actuated, recording psychrometer, mounted in a dust-proof, moisture-proof case located on the wall in the physical laboratory just outside the curing room. This instrument, which is equipped with a 24-hr. clock and a 10-in., 24-hr. chart, records the dry-bulb temperature and the differential between the wet and dry-bulb temperatures.

The chart has two scales, one graduated from 30 deg. to 100 deg. F. in 1 deg. divisions to record the air temperature, and the other from 0 deg. to 10 deg. F. in 1 deg. divisions to record the wet-bulb depression. The scale showing the wet-bulb depression is located at the outer edge of the chart. By this arrangement the two pens are always separated and will not interfere with each other, thus making two separate ink records and eliminating the lapping and smearing which often occurs when two pens traverse the same line.

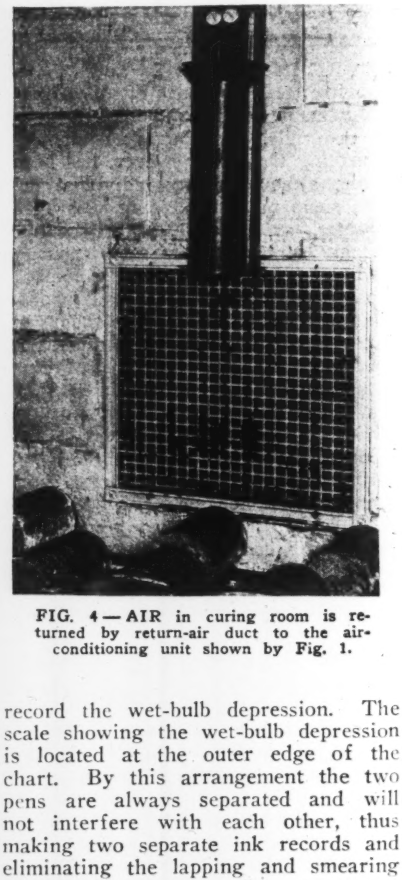


FIG. 4 — AIR in curing room is returned by return-air duct to the air-conditioning unit shown by Fig. 1.

The wet and dry bulbs, motor-driven fan, inverted water bottle, wick, and water reservoir are mounted on a separate brass panel in the curing room. The bulbs are connected to the recording instrument with two 12-ft. lengths of armored moisture-proof tubing. The fan motor is fully enclosed and moisture proof.

No trouble has been experienced in maintaining the required temperature. The relative humidity has never dropped below 90 per cent and seldom drops below 95 per cent. There is no fog in the room, and the air, a complete change of which is obtained every two minutes, carries very little free water. It is not necessary, therefore, to protect the specimens from an accumulation of water.

Freezing range is wide

The specifications for the refrigeration equipment required that the unit have sufficient capacity to lower the air temperature of the cold room from 100 deg. F. to —10 deg. F. within 10 hr. and that it should have sufficient additional capacity to lower the temperature of 54 cu.ft. of concrete, in the form of 6x6x30 in. beams or 6x12 in. cylinders one day old, placed in this room when the air temperature therein was —10 deg. F. from 75 deg. to 20 deg. F. in 20 hr. with the unit operating at not over 85 per cent of its rated capacity. It was also required that during the 20-hr. period the air temperature in the cold room should not be higher than 0 deg. F. and that after this period the unit should have sufficient capacity to maintain the air temperature at —10 deg. F. for any length of time.

The required temperatures are provided by a motor driven automatic, self-contained, water-cooled, ammonia refrigerating unit and evaporator. The compressor (Fig. 3) is of the vertical, single-acting twin (4x4 in.) cylinder, enclosed type; it has a maximum speed of 375 r.p.m. and is driven by a 7½ hp. electric motor. The compressor and motor are mounted on a single concrete base, 3 ft. x 6 ft. x 9 in. thick, insulated from the floor with 2 in. of cork. The compressor has a rating of 2.15 tons under a suction pressure of 2½ lb. gage and a condenser pressure of 185 lb. and is equipped with a scale trap, high-pressure cutout, high- and low-pressure gages, hand-operated stop valves in the discharge and suction lines, and a switch for either automatic or hand operation.

The automatic starting switch starts the motor when the temperature in the cold room rises above the thermostat setting. This switch also stops the motor when the temperature goes below the setting, when the pressure on the high side rises above 225 lb. per sq.in., when the motor is overloaded, or when an undervoltage condition exists.

The condenser, which is mounted horizontally on the compressor support frame, is of combined shell and tube and receiver type, so designed that with the water at 85 deg. F. the condenser will not exceed 185-lb. gage when the unit is operating under the maximum load required. It is equipped with water strainer, removable water heads, purge connection, ammonia drain valve, oil drain valve, and an ammonia safety valve arranged to discharge into the low side.

The evaporator is located in the cold room and consists of 1600 lin. ft. of 1¼-in. full weight ammonia-specification pipe, a surge drum, and an oil separating tank. The evaporator coils are connected in multiple and are arranged to operate flooded. The evaporating surface is designed to carry the maximum specified load at a suction pressure of not less than 2½-lb. gage. The evaporator is also equipped with a high-pressure float valve located in the control room on the wall adjacent to the cold room. This valve regulates automatically the flow of liquid ammonia from the condenser to the evaporator and is equipped with a hand-operated by-pass, which permits rapid flow of ammonia from the condenser to the evaporator when necessary or desired. All coils except those serving for shelves are located overhead with a clearance of 7½ ft.

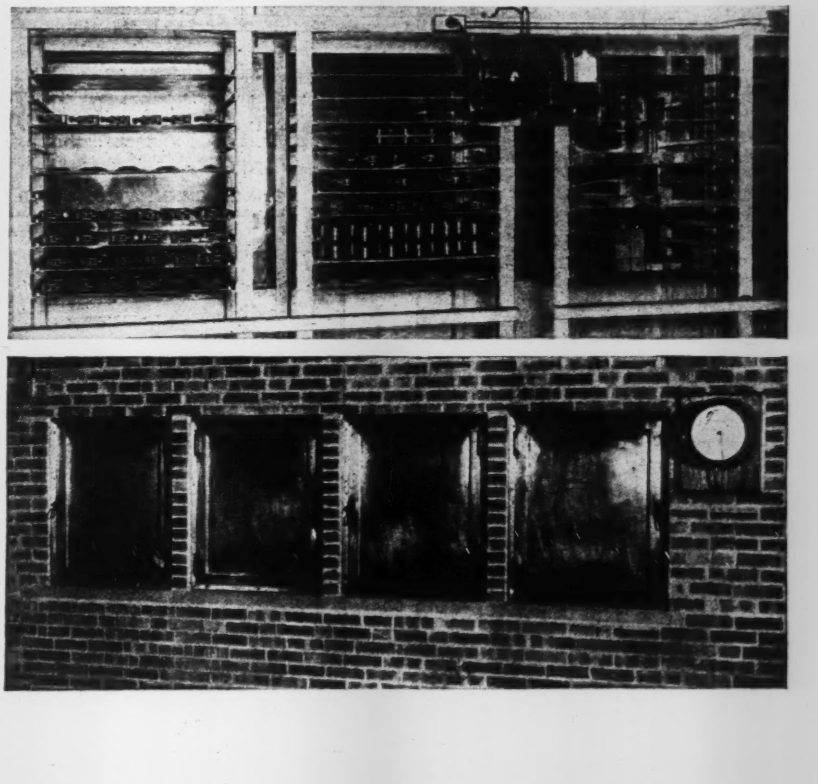
Six shelves, about 30 in. x 11½ ft., spaced 13 in. apart vertically, are provided along the south wall. These shelves are formed by seven of the evaporating coils supported by the same structural iron frame that carries the overhead coils. Each shelf is designed to support either eighteen 6x30 in. concrete beams or an equivalent load of about 1700 lb. distributed uniformly.

The surge drum, which is located overhead in the cold room, has a capacity of about 40 per cent of that of the evaporator coils and is designed to function without the ammonia liquor slugging back to the compressor. The unit is charged with 700 lb. of ammonia. The oil separating tank, located in the cold room near the floor, is 4 in. in diameter and 18 in. long, and is equipped with a drain valve for removing surplus oil from the system. A structural steel frame supports the coils and surge drum.

The cold room temperature is controlled by two remote-bulb mercury-contact thermostats located in the control room. The specifications provided for the installation of only one thermostat having a working range from —20 deg. F. to + 50 deg. F., but when the shipment was being installed, a single thermostat having this range could not be obtained within a reasonable length of time, so two were installed, one having a range from —20 deg. to + 20 deg. F., the other from + 20 deg. to + 50 deg. F. both being connected to a two-way switch so that either may be used, depending upon the temperature desired in the cold room.

A daily record of the temperature in the cold room is obtained from a distance-type mercury-recording thermostat located on the wall of the control room. This instrument is mounted in a dust-proof, moisture-proof case, is equipped with a 24-hr. clock and accommodates a 9½-in. diameter, 24-hr. reverse reading chart, graduated from —20 deg. to + 100 deg. F., in 2-deg.

FIG. 5—SHELVES FOR small specimens (top) in the curing room are accessible by a reach-in door (bottom) opposite each of the four tiers without entering the room; recording psychrometer is shown in bottom view at right of doors.



divisions. The mercury bulbs are connected to the recorder by 12 ft. of flexible bronze-armored tubing.

Due to the excellent insulating efficiency of the materials used in constructing this room and the ample capacity of the refrigeration equipment, it is only necessary for the unit to run about 10 per cent of the time to maintain a temperature of 0 deg. F. plus or minus 2 deg. F. for ordinary routine work. While no attempt has been made to determine the minimum temperature that may be obtained, a temperature of — 20 deg. F. is obtained quite easily. From two to three hours are required to freeze small specimens, and two complete cycles of freezing and thawing may be obtained daily if desired.

Harpers Ferry Railroad Bridge Revamped for Highway Use

By P. G. Lang, Jr.,
Engineer of Bridges, The Baltimore & Ohio Railroad, Baltimore, Md.

THE LOSS in the floods of March, 1936, of four spans of the famous Bollman-truss railroad bridge over the Potomac River at Harpers Ferry, W. Va., used for highway traffic since 1894, left that town without a highway connection to the north. Studies for the construction of a new highway bridge were immediately inaugurated and have since been in progress. However, to await the conclusion of the long preliminary studies required for a major project of this character, involving, in the present case, negotiations between the three states of Maryland, Virginia and West Virginia, would have seriously inconvenienced the town of Harpers Ferry. In this crisis, the Baltimore & Ohio Railroad permitted the use of its truss bridge for highway traffic, and undertook the requisite adaptation of this structure to highway use.

TIMBER DECKING on B.&O. bridge serves Harpers Ferry highway traffic until a new bridge can be built. The foundations of the washed out Bollman truss spans appear at the left.

The unique situation at the Potomac River crossing of the Baltimore & Ohio Railroad at Harpers Ferry was outlined in an article by the writer in *Engineering News-Record*, Sept. 17, 1931, p. 446. With the completion of the railroad company's new deck plate girder bridge and line change in June, 1931, there existed at this point, in close proximity, three bridges representing railroad bridge design practice at widely separated periods.

The easternmost bridge, consisting of wrought iron Bollman truss spans, completed in 1870, rested upon the original masonry used for the support of the timber "arches" designed by Lewis Wernwag, which carried the tracks across the river in 1836. The reconstruction of this bridge as a series of Bollman truss spans, commenced in 1851, was, due to the Civil War and other causes, not completed until 1870. Between that year and 1894 this bridge was used for all the main line traffic.

In 1894 a new bridge and tunnel were completed, representing material improvement of the alignment and providing for railroad traffic a bridge of what was then deemed to be modern design. The Bollman truss bridge was turned over to the public authorities and adapted to use as a highway structure, which purpose it served during the succeeding 42 years. In June, 1931 the B. & O. completed an improvement which involved a new deck plate girder bridge crossing the river on a tangent with the track through the tunnel, and main line traffic was then transferred to this structure. The bridge that had gone into service in 1894 was retained for the moderate traffic passing to and from the Shenandoah Valley branch, which joins the main line at this point.

While the 1894 structure was originally built as a double-track bridge, the moderate railroad traffic to which it had been subjected since 1931 was fully accommodated by one track. Revamping the bridge for highway service, therefore, was not a difficult operation. A wooden plank floor was installed covering the entire bridge and providing a roadway with a minimum width of 23 ft., adequate for two-way highway traffic and for one railroad track. When the bridge is used by trains all highway traffic is stopped.

Access to the Maryland or North end of the bridge is provided by a roadway skirting the toe of the mountain through which the railroad tunnel passes. On the West Virginia side of the river, access to the bridge is over a short stretch of new roadway.

The work on the roadway approaches was done by forces of the two states concerned. The bridge, which was opened to highway traffic on Oct. 11, was adapted to highway purposes by the railroad company and, at the request of the public authorities, was rushed to completion within a few days. Special signal facilities insure absolute safety of road and rail traffic.

THREE GENERATIONS of B.&O. Railroad bridges at Harpers Ferry as they appeared before the floods of last March washed out the Bollman truss spans (farthest down the river) used for highway purposes since 1894.

THE TENNESSEE VALLEY EXPERIMENT—IV

River and Region

Development of the Tennessee River for navigation, water conservation, flood control and power involves many regional problems, including cover-cropping and forestation to check erosional silting, and development of recreational and mineral resources

PERMANENTLY successful control and development of a great stream such as the Tennessee River presents many off-river problems on which the ultimate value of the river work depends. The most formidable problems are those affecting the life of reservoirs and channels; this life is determined by the rate of silting, which in turn depends on how effectively the farm soil is protected from erosion, as well as on the type of forest management, and adequate control of waste land. A different group of problems bears on the economic justification of the river work, since the river development is a losing investment unless the region prospers. This in turn requires that agricultural, forest and recreational resources be effectively utilized. These are matters that involve many difficult factors of economic, political and human relationships under the best of conditions, and they are not easy to handle.

In no single great river basin of the United States are the off-river problems so complicated and so diverse as in the Tennessee Valley. For this reason the procedure of the TVA in dealing with them is outlined in the present article, supplementing the account of river development work given in the four preceding articles (*ENR*, Dec. 3, 10, and 17, 1936, pp. 771, 823, and 860).

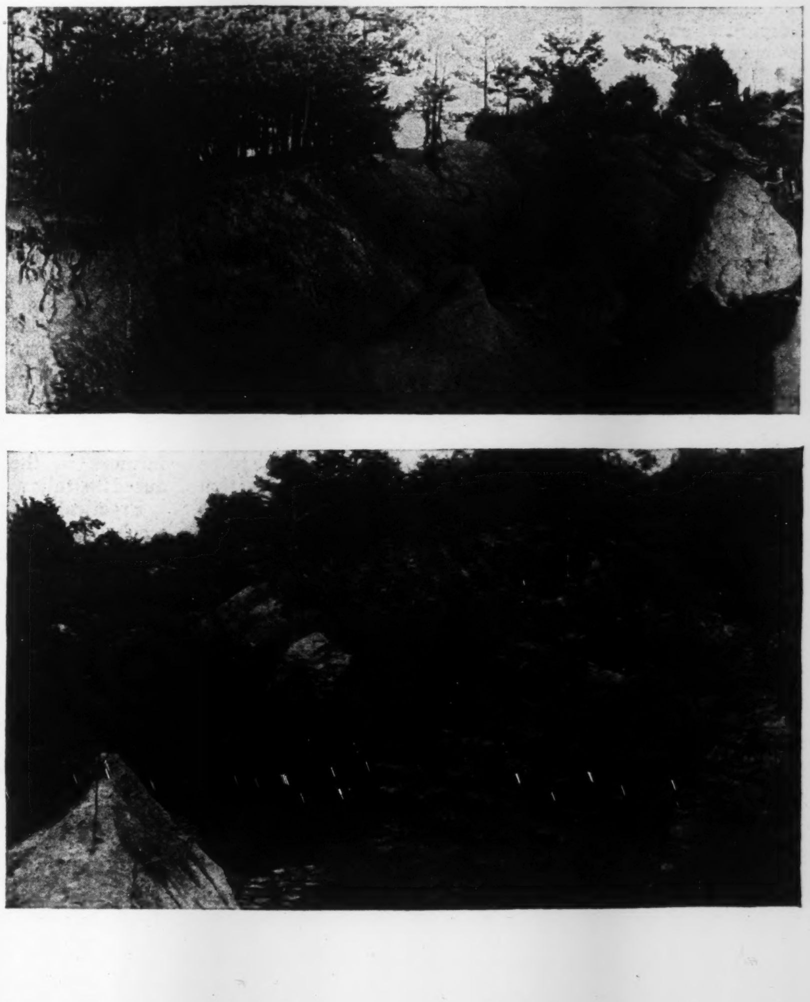


FIG 1—BADLY ERODED LAND cannot be restored to its original condition economically but erosion can be checked by a forest cover. The lower picture shows such an area one year after planting black locust seedlings.

It is obvious that extensive studies must be made before suitable methods of overcoming the difficulties contained in off-river studies and development can be worked out. Further, experience has shown that even after adequate data have been obtained and the problems have been solved on paper it takes years to produce results of real magnitude. Because of these facts the TVA during its 3½ years of activity has had time for little more—outside of its huge construction program—than to make a reconnaissance of the soil, forest and other regional conditions.

When its operations began, the TVA found that a good deal of information about these conditions was available from earlier work done by different local, state and federal organizations. But this information proved to be neither complete nor conclusive. Practically none of it had been collected with the idea that it might be used in working out a regional development plan for the Valley as a whole. Accordingly, the TVA was forced to start from scratch in most of its off-river development activities. It found little in the way of local sentiment to help it.

Nevertheless even in the short time since actual work could be started, significant results have been accomplished in some phases. This is notably true of the promotion of improved agricultural methods to reduce soil erosion and retard the silting of reservoirs — one of the two primary regional problems from the river engineer's standpoint. In the other problem, control of forest and waste or submarginal land, progress has been much less extensive.

Because Congress directed it to manufacture fertilizer for demonstration purposes and conduct demonstrations on a broad scale, the TVA undertook to find new processes for producing fertilizer from the phosphate minerals of the Valley, large deposits of which are available. Nitrates can be supplied to the soil by the nitrogen-fixing action of legumes. Lespedeza, one of the best of these, has been planted extensively by the local people upon the urging of the state colleges, backed by the TVA.

Phosphoric acid, however, must be supplied by artificial fertilizer. The TVA's chemists, under the lead of Harry A. Curtis, were successful in working out electric reduction methods by which phosphoric fertilizer in highly concentrated form could be produced at low cost. Thereupon it rebuilt one of the old wartime nitrate plants at Muscle Shoals and proceeded to produce fertilizer.

With fertilizer available, the TVA organized a program of field trials by farmers, with the active and effective cooperation of the Valley counties and states and of the United States Department of Agriculture. The program is based on the theory that the farmer will grow more grass and cover crops (which prevent soil erosion) as soon as he can prove on his own land that such procedure is of practical value.

Working entirely through the agricultural extension service set up in each state as an auxiliary of the land-grant college in that state, TVA has built up a valley-wide organization for the purpose. With few exceptions the counties in the Valley each had a farm demonstration agent, whose salary and expenses were paid partly by the county, partly by the state and the rest by the federal government. To such counties TVA made the proposal that it would pay the salary and expenses of an assistant agent who would get across to the farmers the TVA soil-erosion prevention program based on the substitution of cover crops for those that call for clean cultivation. These assistant county agents, numbering more than 100, are selected and employed by the state agricultural extension service but paid and supervised by the TVA.

With this set-up, over a thousand farmers with nearly 2,500,000 acres under their control were induced to adopt many constructive practices, including growing more grass and cover crops. Free concentrated fertilizer, for which the farmer pays only the freight is the inducement; there was no attempt at any kind of compulsion.

H. A. Morgan, with a lifetime of experience in working with farmers through the state extension organizations, developed the demonstration program. He has been ably seconded by J. C. McAmis, who was with him in similar work at the University of Tennessee.

These agricultural results constitute one of the outstanding TVA accomplishments to date. They have already convinced thousands of Valley farmers that it pays to grow grass and cover crops. While the actual increase in the number of acres diverted from row crops to those which reduce soil erosion is still but a small fraction of the total—since about 13,000,000 acres of the Valley's area are agricultural land, that is, other than essentially forest land—yet definite progress has been made over the entire basin, though not without radical change in the thinking of a highly conservative population. In the meantime, as TVA studies indicate, no serious silting of its reservoirs will occur, so far as the farm lands are concerned.

Silting from non-farm land

A problem yet to be solved is how the silting caused by erosion of non-agricultural land may be prevented at practicable cost. Roughly 13,500,000 acres of the Valley, or more than 52 per cent of its entire area, are designated as forests or as land suitable only for the growth of timber. In addition, there are large areas of submarginal land, that is, land which in the long run will not support even subsistence farming. Further, it is a question whether much of the land in the agricultural classification has not been so injured by loss of topsoil through erosion that its fertility cannot be restored at practicable cost.

Although nearly 50 per cent of the basin has some form of forest cover much that has been labeled "forest lands" has in the main been cut over so closely that it bears little more than scrub brush. Reforestation has been carried on only locally, on a small scale, and is represented by barely a few dots on the map. Meanwhile much of this so-called forest land has eroded badly. A great deal of it will continue to wash seriously, unless a feasible method of starting timber growth on it is developed. TVA has done a great deal of experimental work to that end; its forestry forces have cooperated with the United States Forest Service, the Civilian Conservation Corps, the forestry departments of the states, and private land owners.

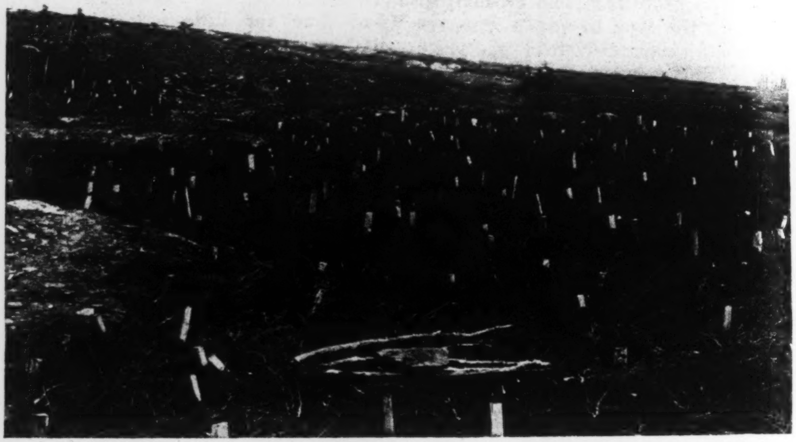


Fig. 2—Gullying of the land can be checked by brush mats until a forest cover is established

From the work thus far done by the forestry division, of which Edward C. M. Richards is chief, it has become conclusively evident that mechanical methods of preventing soil erosion on non-farm land run up the cost beyond reason. These methods include particularly the construction of small rock check dams, and similar operations involving much hand labor. The cost usually exceeds the value of the reclaimed land. On the strength of its experience the TVA is neither doing nor recommending much erosion-preventive work of such character.

Terracing along the contours of rolling or steep land subject to quick erosion when unprotected has proved effective in reducing soil wash. Such work is considered the responsibility of the individual land owner. By demonstration and persuasion thousands of farmers in the Valley have been induced to follow such practices.

Practically no erosion-preventive work has been done by the Authority's own forces, but in co-operation with the Civilian Conservation Corps, TVA has directed such work in some areas scattered throughout the Valley. At the peak of such CCC work that organization had 42 camps with 200 to 300 young men each, doing a wide range of work. Two tree nurseries were operated to produce seedlings for replanting eroded areas owned by TVA adjacent to Norris and Wilson dams. In lands controlled by the TVA that are to be returned to forest the natural timber growth was encouraged by CCC removal of brush and dead trees and similar culture.

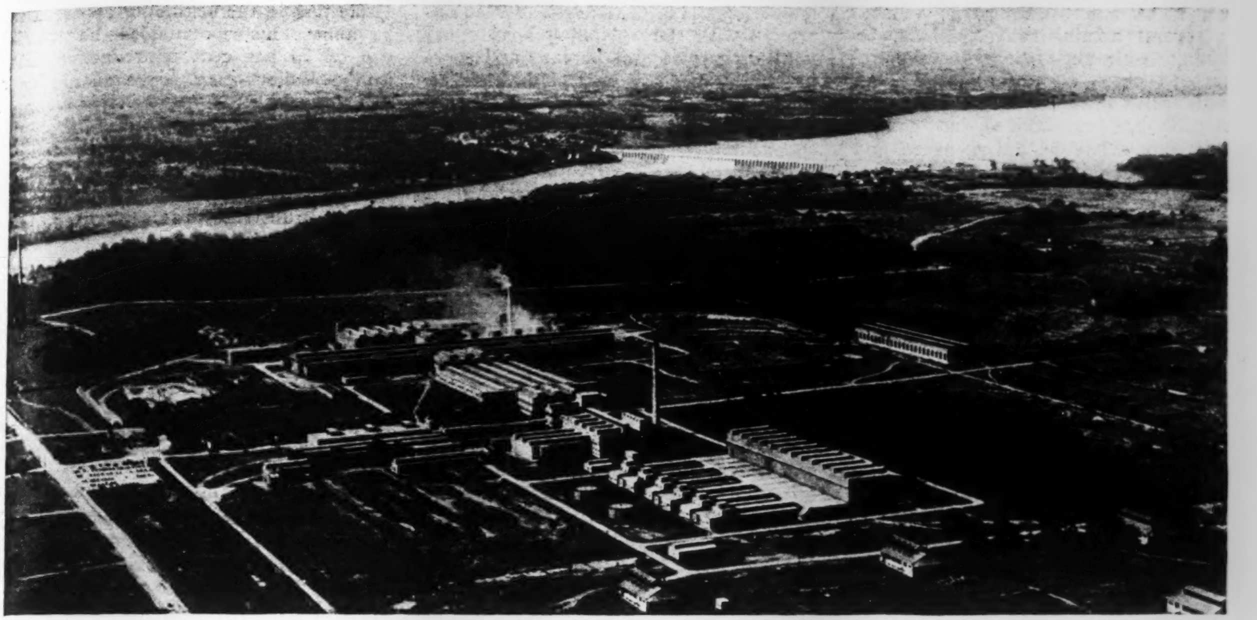


Fig. 3—Nitrate Plant No. 2 at Muscle Shoals is now producing fertilizer for large-scale experimental work. In the background is Wilson Dam.

Certain of these CCC camps also co-operated with small farmers in checking serious erosion on private land, as local demonstrations. Taken as a whole, however, the combined TVA-CCC soil-erosion work covers a negligible fraction of the total area. The main accomplishment by TVA in these co-operative CCC undertakings has been to determine good and poor methods of doing the job in the vast territory in which soil erosion must be stopped. How to induce private owners to push erosion-preventive work along the lines followed by the TVA-CCC projects has not been determined. Whether the private owners will ever do so appears to be questionable, and thus the net result of such work to date seems to be confined to the areas actually covered.

Forestation methods

Terracing is not applicable to land that is to be devoted to tree culture, because of cost. To determine how best to start trees on lands suited only for timber, the TVA forestry department has carried on experimental and demonstration work on a 117,000-acre tract surrounding the lake created by Norris dam. Most of this area is rolling to steep and has poor soil; a good deal of it is badly eroded, but scrub pine, black locust and shortleaf pine grow well on it. Results already secured from extensive plantings on this tract indicate that a protective cover can be produced in a comparatively short time.

Along with this definite demonstration work it has been necessary to make comprehensive surveys to map the areas suitable only for forest growth. Much of this field work has been completed by TVA. Airplane pictures made for other uses by the Authority were taken as the basis for the surveys, and supplementary ground checks of sufficient accuracy for the purpose were made at low cost.

After this preliminary work it remains to be determined how to get timber started. The United States Forest Service already is administering large national forests along the slopes of the high mountains in the eastern part of the Tennessee River basin. Close to 90 per cent of these slopes have been designated by that Service as eventually being best suited for national forests.

TVA has so far not decided on means for reforesting the remainder of the 13,500,000 acres in the Valley that is considered suitable only for timber.

This huge problem area is practically all in private hands. Much of it may be bought at $2.50 to $10 an acre. Since few of the owners would be willing or able to finance proper forestation of their lands, the only solution of the problem appears to be some method of public acquisition and management. The states of the Valley have not indicated that they are interested in doing the job.

Distribution and sale of electricity

Unquestionably the most publicized, the most praised and the most criticized of all of the TVA activities has been its program for the distribution and sale of the electricity generated by the power plants at Wilson, Norris and Wheeler dams. Due to legal difficulties in which the TVA has been increasingly involved by the private utilities in and adjacent to the Valley, TVA has actually made very little progress in expanding its delivery of electricity directly to cities, towns, counties, and co-operative organizations as it was designated to do in the original act. Most of its huge volume of kilowatt-hours generated still is sold wholesale to private utilities.

An impressive start has been made, however, in closing contracts with municipalities, counties and public groups under various set-ups to sell electricity to these organizations at very low wholesale rates under restrictions on the resale rates that may be charged. TVA figures show that these communities have all made money under these contracts. Opponents of the program claim that all the costs of the operation of TVA electrical sales and promotion are not included. Until there have been enough consumers connected to the TVA system to strike an average over the Valley as a whole, and until much more information is available that is acceptable to independent auditors, the TVA electrical distribution and sales program hardly may be properly judged.

But TVA has had an enormous effect on rates to household and rural consumers of electricity in the Valley and contiguous areas. Reductions in domestic rates throughout the nation during the last three years, since TVA began operations, are credited by TVA proponents to the activities of the latter. The private utilities deny this claim.

Whether TVA ever makes much further progress in its present electrical program depends on the character of the decisions that may be made in a number of suits pending, as well as on several administrative policies, beginning with the federal administration and extending through the TVA itself. Until these basic features of the situation are crystallized, no conclusions may safely be drawn as to how TVA will handle the distribution and sale of the vast amount of electricity being generated and to be generated by its power plants.

Recreational resources

Location, climate, topography and the existence of vast tracts of land that under a long-range regional development program will eventually be devoted to tree growth combine to indicate that the upper reaches of the Tennessee Valley may become one of the most popular recreational areas in the country. Last year more than a million people from all parts of the United States as well as Europe and Asia visited the TVA dams and other projects—an indication of what may come to pass in the way of attracting visitors to an area that hitherto has had little tourist business. The fact that the still unopened Great Smoky Mountain National Park this year will have more visitors than any other national park is a further indication of the possibilities.

Here is the big importance of the possible tourist revenue: Large areas of the Valley will for many years be unable to make a living in any other way. The income from cut-over lands will be negligible for a generation or more; TVA's forestry division believes it will not even be enough to police the woodlands. Yet trees are the only effective cover for the steeper lands that will protect the streams and reservoirs of the system against silting. If during the long wait for an income from timber products it is possible to develop a substantial income from facilities for hunting, fishing, and various outdoor sports, the economic position of the project is greatly strengthened.

Great numbers of people can enjoy outdoor life in the Tennessee Valley and still leave the area unspoiled. It is so vast and wild that it will never be crowded. Forest Service experience in handling several million acres of southeastern mountain lands, part of which are in the headwaters of the Valley, shows that game, birds, and fish increase in protected areas at a remarkable rate. Fully two-thirds the population of the United States lives within two days' drive and within overnight rail travel of the eastern end of the Valley, where most of these lands lie.

Recognizing these conditions, the land-planning division of the TVA, under the direction of Earle S. Draper, has been studying the recreational resources of the Valley as a valuable but undeveloped regional asset. In co-operation with state planning boards and with various federal bureaus and services it has made surveys of the existing facilities—highways, safe water supplies, pure food and milk sources, and sport facilities and attractions.

Based on these surveys, the cooperating groups are laying out great areas on a zone or province basis. The high mountains, comprising several thousands of square miles above 2,500 ft., with some peaks above 6,000 ft., form one province. The Cumberland mountains, having other attractions, are a second province. The Cumberland plateau, where all the land is unfit for farming, makes up a third province, at altitudes of 2,000 to 3,000 ft. Between these higher areas is a long rolling valley, in which quite different attractions already are drawing large numbers of tourists. TVA and the cooperating states and federal bureaus see the need for definite planning of these four provinces to the end that visitors may reach them quickly and safely over good highways, properly located for present and future tourist traffic.

The 440-mile Blue Ridge scenic parkway, 40 per cent of which is under construction, is destined to become a main trunk route in this vast tourist highway transportation system. Plans for recreational facilities also contemplate lakes, water supplies, sewerage, camps and other projects that are major parts of the regional undertaking as a whole. How these plans will be financed and executed is being studied from all angles. It is significant that the National Park Service expects the Great Smoky Mountain National Park to be able to carry all expenses of operation and upkeep soon after it is officially opened. Studies also show that a very low toll on the Blue Ridge Scenic Parkway will make that unrivaled tourist highway a paying proposition.

TVA has experimented with two small recreation parks near Norris dam. This past season, under none too favorable conditions, both of these parks met their operating and upkeep expenses. They have a number of cottages and every modern facility for comfort and safe entertainment of guests. However, present TVA thinking is said not to incline toward more parks built and operated by itself. Rather, the idea is to induce private interests to provide the right kind of facilities, convincing operators by education that safe water supplies, proper sewerage and similar facilities pay. Close control of all places catering to the public already is exercised by the boards of health of all the Valley states.

Briefly, it is possible that the Tennessee Valley's woodlands will in time produce an income comparable with that of the better farm lands. Thus, the obstacle that in the beginning appeared to be almost insurmountable—the handicap of 50 per cent unproductive land in the Valley—may prove an aid and a resource, by earning well for a large number of permanent residents through properly planned recreational facilities.

Industrial development

While industrial development is not directly part of the engineering phase of regional development, it is plain that the vast expenditures involved in the dams' reservoirs and power plans cannot justify themselves unless a substantial amount of industry grows up in the Valley. Otherwise the development is unlikely to be self-liquidating, and, becoming a national charge, will turn out to be economically unsound. To date the Tennessee Valley regional development is in this respect unsound from the business point of view. The Valley not only has little exportable agricultural surplus but its industrial development is still more limited. The bulk of the population is on a subsistence-farming basis.

But there are many important industrial opportunities, of both small and large size. Some have been developed during recent years by private interests, notably in the operations of the Aluminum Company of America at Alcoa and the extensive operations of the Eastman Kodak interests at Kingsport, both in Tennessee. Three of the largest rayon plants in the country also have been established in the Valley in the last decade. On the whole, however, there are comparatively few important industries in the Valley. There is need for industrial research to show the way to further growth.

Ceramic research

An industrial and agricultural research division set up by TVA has done much work along these lines, but without attracting any industries. Since the TVA's establishment the only major industry to locate in the Valley has been the Monsanto Chemical Co., which is erecting a large plant in the Tennessee phosphate fields to make phosphoric acid and related products. This plant was attracted, it appears, by cheap TVA power and a source of raw material.

One industrial research development of the TVA, however, deserves special note. This is the work accomplished in the ceramic research laboratory set up near Norris dam. The objectives of the work were two: first, to determine better methods of mining and refining the china clays of the Valley, to the end that the country as a whole might be independent of foreign sources in time of emergency; second, to find methods of electric firing applicable to the higher types of ceramic whitewares, now largely imported.

The laboratory's first objective has been accomplished, with the result that one modern kaolin refining plant has been placed in operation by private interests and a second will shortly begin to produce. These plants are expected to make primary kaolins equal to any in the world and far superior to former domestic kaolins.

The electric firing work has shown results of such promise that a pilot plant will shortly be started by TVA to demonstrate that this method of making the higher types of fine chinas is commercially attractive. A market for large blocks of electric power may thus be created, since all of the raw materials for high-grade ceramics production occur in the Valley. TVA has no plans for manufacturing ceramics, but expects private industry to take advantage of its findings.

Other research in aid of industry has been confined to mineral resource exploration under the direction of E. C. Eckel, chief geologist, who has studied the detailed geology of many parts of the Valley. While most of the work was done in connection with dam sites, reservoirs and other structures, more intimate knowledge has been obtained of various basic minerals that might be used in the development of industries or for military purposes.

In general, the mineral resources of the Valley were fairly well known before TVA entered on the scene. Some highly mineralized sections, however, require detailed geological attention.

Social and economic research

Ever since its first days, TVA has given more attention to the social and economic aspects of its operations than is common on private (or for that matter on most governmental) projects. In fact, so much has been said and printed about the TVA's activities in these directions that the facts in the case have been completely distorted.

Social and economic studies were concerned mainly with two questions: first, what are the injurious effects likely to result from construction of the various dams and from purchase of large areas of land for reservoirs; second, what steps are necessary and desirable to correct for these effects? Other studies have related to general social and economic problems, which may become important in future, but those concerned with the conditions arising from the big construction work are receiving present attention.

Before actual work on a dam is started every family living in the affected area is consulted in detail about its affairs—financial status, health, history, and all pertinent conditions of the family. These are factors to be considered in planning the relocation of the families, but thus far TVA has made no serious effort to find new sites for the families displaced by dam and reservoir construction. It did offer to transport the people to look over prospective new locations, and when requested also offered advice and assistance, but in no case has it taken a paternalistic attitude. Some TVA people believe that an opportunity has been missed in not working out a relocation plan for each family, but men who know the type of people in the Valley question whether such a plan would be well received.

Where displaced families go

Few of the families who had to move to make way for Norris reservoir moved very far; some actually moved into the area directly adjacent to the reservoir reserves. Only a very small number moved to cities.

A related condition resulting from dam and reservoir construction was the necessary rearrangement of roads, schools, and other local facilities, which proved to form a complicated problem with endless variation in detail. Prejudices, county pride and similar intangible features made the solution of the problem difficult. In many cases, solutions were facilitated by economic and social studies to determine the real conditions involved.

As to the effect of the land purchase operations on county government, studies by a federal agency have shown that local tax conditions have by no means always been affected adversely by the retirement of the purchased land from the tax rolls. In some cases the remaining lands of the country have increased sufficiently in value so that, with proper re-assessment, the service on outstanding bond issues could be met without a tax increase.

Lack of local cooperation

One of the discouraging features of the TVA's experience has been the almost total lack of local financial cooperation in the regional development project. Aside from local participation in the soil conservation work and the interest of the population in obtaining a supply of low cost power, there has been surprising apathy toward the TVA's work on the part of the people of the Valley. The only local contributions offsetting the huge federal expenditures invested in the project are those represented by the agricultural and electric program.

Complete equalization of Tennessee River flow being out of the question, it was obvious that local high water hazards would require levees and other works to supplement the water regulation. Notable among the localities thus affected was Chattanooga. What has occurred there since TVA operations began is closely representative of the valley-wide attitude toward the project.

Chattanooga has long been aware of its flood hazard in a general way, and some time ago a municipal commission was appointed to study the problem and recommend methods of protection, mainly levees. It was contemplated that the city itself would finance the cost of this work. But very soon after the TVA started operations this commission was disbanded, and since then the city has done nothing to meet a great flood disaster—which is almost certain to come. The local feeling is that TVA should and will do the job.

While Chattanooga's failure to cooperate with the TVA on its flood problem is an outstanding example, it is merely typical of the attitude in the Valley. Except in connection with getting cheap TVA power, in no single instance has a city, town or county in the Valley proposed to raise funds to supplement the federal money that TVA is spending or to help in building any part of the works planned.

Summary

The off-the-river physical accomplishments of the Tennessee Valley Authority to date have thus been confined mainly to widespread demonstration and acceptance of methods of farming which reduce soil erosion to a negligible amount, and to the distribution and sale of electricity generated by its water-power plants at Wilson, Norris and Wheeler dams. The agricultural program has been impressive and the results effective. The net results of the present electricity program remain to be determined.

In practically all of its other off-river undertakings TVA has to date done little more than to accumulate by research, by fields trials and surveys, by coordination of existing information and by other methods a vast amount of material on which to base solutions of the involved social, human, financial and physical problems met in working out a long-range regional development plan. Why no more progress has been made and why along most lines there is little likelihood of early progress in real regional development by the TVA will be discussed in the concluding article of this series.

In working out the problems of river development that extend back into the land areas of the basin region, various parts of the organization have been engaged in cooperation: engineers, geologists, agriculturists and foresters. The following, among others, carried the leading responsibility: A. S. Fry of the engineering data division, Ned H. Sayford of the engineering service division, Edwin C. Eckel, geologist, J. C. McAmis of the agricultural division, E. C. M. Richards, forester, H. A. Curtis, chemical engineer, and Earle S. Draper, in charge of land planning and housing.

CURRENT HIGHWAY PROBLEMS—XII

Secondary or Feeder Roads

Principles governing selection and sequence of improvement and minimum design standards for light traffic

By C. N. Conner

Senior Highway Design Engineer, Bureau of Public Roads, Washington, D. C.

INCREASED CENTRALIZATION *of control over secondary roads has done much to standardize design and construction. Federal and state highway authorities have laid down governing rules for distribution of improvement and for line and roadway design. The following article is a statement of these rules prepared for the first time for general engineering information by an engineer of the federal bureau chiefly engaged in their field application. As the first code of principles for the economic planning and the engineering design of secondary roads the following text has a definite interest.* —EDITOR.

THE SECONDARY ROAD has sprung into prominence recently both in federal and state road-building activities. For the five-year period, 1930 to 1934, there was an increase in surfaced mileage of 211,900 mi. of low type and 6,247 mi. of high type road surfaces. During the previous five-year period, 1925-1929, low type surfaces were increased by only 99,530 mi. and high type surfaces by 15,022 mi. This increase in the improvement of secondary roads has been made possible largely through federal funds administered by the Bureau of Public Roads and other federal agencies, and by road-user revenues collected by the states.

With the increase in secondary road activity and because of federal participation there has come about a more settled practice of design and construction that approaches characterization as standard. It is this standard that is considered in respect to (1) selection and sequence for improvement and (2) minimum design requirements for roads carrying light traffic. In substance the principles and practices summarized are those laid down by federal authority as requisite for secondary roadwork in which federal funds are employed.

Problem will persist

In the past most of the less-important roads have been improved by local authorities using funds and methods available to them but there was no coordinated effort by any agency to make these roads a component part of a national highway system. Ten and fifteen years ago and until recently the federal government and states properly have been building a system of main highways. The time has come, however, when state and federal authorities must direct attention to broadening their highway-improvement program to include those secondary roads needed as feeders to the trunk highways. Such a program is needed now to bring roads and services from urban areas to rural communities and from rural areas to the metropolitan districts. It also appears reasonably certain that the federal government and state governments will continue to build roads extending from the improved main network into the farm communities as a necessary part of a national highway system.

The state-wide planning surveys now being conducted by the state highway departments with federal funds under the advice and direction of the Bureau of Public Roads will, when completed, provide facts on which to base future construction programs on the federal-aid highway system, the state-highway systems and on secondary or feeder roads leading to these systems.

As viewed by the federal government and most state governments, the term secondary or feeder road refers to rural roads not included in the federal aid or state-highway system in states which have not taken responsibility for county or township roads. In states which have taken such responsibility the term includes roads not included in the federal-aid or former state-highway system. Roads of the above classification, of course, include farm-to-market roads, rural free-delivery mail roads and public-school bus routes.

The principles for selecting secondary roads for improvement have been studied by the Farm Roads Advisory Committee appointed by the Secretary of Agriculture on whose membership are representatives of the Bureau of Agricultural Economics, Bureau of Public Roads, Land Policy Committee, Works Progress Administration, Rural Electrification Administration, Rural Resettlement Administration and the Post Office Department.

The committee's recommendations, while applying specifically to secondary or feeder roads to be improved with funds apportioned to the states under the Federal Emergency Relief Appropriation Act of 1935, may well be used as a present guide in selecting projects of this character whether or not financed with federal relief funds. They probably are the most useful principles so far adopted by any qualified agency.

Aside from the relief features, the committee's recommendations on selection of secondary or feeder roads paraphrased briefly are as follows:

Consideration shall be given to the possibilities of creating economic and social values in the areas served by the proposed improvements. In this decision it is as important to consider the values that may result by denying improvements and so encouraging abandonment of unproductive and physically-handicapped areas as to consider the positive values resulting from improvements in desirable areas. In this connection consideration should be given to available information in regard to: (1) the location of submarginal agricultural lands; in the absence of strong local reasons projects proposed for construction of secondary or feeder roads in submarginal areas should be denied; (2) The location of predictable developments likely to increase density of land settlement.

Subject to the foregoing considerations preference should be given to roads that connect farms and rural homes with railroad and water-loading points, schools, churches and other points of public congregation, including community developments and unincorporated villages. Also, in the absence of compelling reasons to the contrary, sections of secondary or feeder road proposed for improvement should connect with the previously improved highway system, and preference be given to projects that connect with the improved system at both ends.

No proposed improvement should be approved unless a definite need for such improvement can be demonstrated. Need of improvement will be indicated by the existence of either or both of the following conditions: (1) Impediment or hazard to travel at any season, and (2) Excessive maintenance cost of the road in its present state.

Selection of roads found to be in need of improvement should be made on the basis of relative importance and amount of potential traffic. The character of the traffic should be considered as well as its density, and the aim be to promote the improvement of those roads that to the greatest extent facilitate transportation of farm products to markets and mills and extend to rural areas the benefits of urban development.

Selection between roads of similar usefulness in respect to the character of their traffic should be made on the basis of their estimated potential traffic. In the absence of specific reason to the contrary potential traffic order is to be assumed to be the same as the order of present average daily (24 hour) traffic density: (1) All roads serving traffic in excess of 100 vehicles daily; (2) All roads serving traffic of densities between 100 and 50 vehicles daily, and (3) Roads serving less than 50 vehicles daily.

No project should be approved unless it be determined that the work proposed to be done will result in a substantial improvement of the roadway. Work properly classifiable as maintenance is not to be approved. Improvements should be capable of maintenance under the existing and estimated potential traffic at reasonable cost. Authorities legally charged with the administration of secondary or feeder roads selected for improvement should be required, by specific agreement, to maintain the roads after improvement.

Improvements of secondary or feeder roads made under the administration of county or other local highway officials should conform to standards established for improvement of roads of like class, traffic density and other conditions, by the respective state-highway departments with the approval of the U. S. Bureau of Public Roads. It is not contemplated under this direction that the high standards of construction ordinarily established for trunkline and state highways shall be carried over into work on secondary or feeder roads, but it is anticipated that the work done shall result in a material betterment of the existing condition.

Minimum design standards

The following general recommendations are made for the design and construction of roads and bridges for use between rural areas and a principal highway, shipping point, trading point or population center where traffic will be light in volume and weight, amounting to less than 100 vehicles daily and consisting of automobiles and light trucks on pneumatic tires. It is assumed that a reasonable effort will be made to locate and construct the roads for pleasing appearance, as well as utility. To this end the location may be somewhat winding, with provision for preserving the natural growth of trees and shrubs and the planting of suitable vegetation.

The following minimum standards are suggested as the basis for developing plans, specifications and estimates.

Alignment—The right-of-way should have a width of 50 to 80 ft. sufficient generously to accommodate the road section. An alignment is required involving no sharp turns and other features likely to be dangerous for the anticipated volume of traffic. The radii of curves should be as long as the charcater of the country and permissible cost of construction will permit: In coastal and plain country 20 deg., radius 288 ft.; in rolling and hilly country 20 deg., radius 288 ft., and in foothills and mountainous country 60 deg., radius 96 ft. Curves of 3 deg. and over should be widened and superelevated, with a sight distance of 300 ft.

Profile—It is not considered advisable or necessary greatly to reduce intermediate grades or to increase expenditures appreciably to obtain long straight grades. In following an old road sufficient relocation should be made, however, to obtain reasonable maximum grades. In mountain location it may be economical to use short stretches of grade which are steeper than the long ruling grade, to avoid expensive and dangerous alignment. If consistent with future plans, excessive grades should be so located or compensated as to permit grade reductions at a later date. For example a 9 or 10 per cent grade may be used for a short distance to reduce the cost of initial construction where higher standards such as 7 ro 8 per cent grade will be used later to replace the original 9 or 10 per cent. The grades recommended are: 6 percent for costal and plain country; 7 percent for rolling and hilly country; 8 percent for foothills and mountains, and vertical curves 200 ft. and longer if necessary to obtain 300 ft. sight distance.

PREVIOUS ARTICLES IN THIS SERIES

▼

A Highway Holiday?
Freeway at Intersections
Writing a Highway Constitution
Fitting the Road to Future Traffic
Future Federal Aid
Township Roads
Intercity Arterial Roads
Taxes and Transfer of Control
Long-Time Planning
Road Users' Taxes
Express Highways

Cross Section—Good design requires a graded width of roadbed in easy topography, of not less than 26 ft. out to out of shoulders, and in rougher topography 24 ft. out to out of shoulders, with an absolute minimum width of 20 ft. overall, (surfacing plus shoulders) in mountainous country. In detail the requirements are: A crown slope 1/2 to 1 in. per foot depending on character of material; ditch slopes on side toward center line 1 on 3; side slopes in cut, earth 1 on 1½ and extra firm earth and rock 1 on 1; rock 1 on 1/4; side slopes in fill, 1 on 2 in. earth and 1 on 1 in. rock, but 1 on 1½ may be used in earth there is no probability of erosion.

Surfacing—A minimum surfacing width of 10 ft. for single track roadways; a minimum of 14 ft. for an estimated maximum daily traffic up to 250 vehicles, and a minimum of 16 ft. for an estimated maximum traffic in excess of 250 vehicles are advised. Where featheredge section is used and local surfacing materials are plentiful, the width of surface should be out to out of shoulders. The thickness of surfacing is to vary with the character of the sub-grade and type of surfacing material: For gravel, crushed stone, slag and chert 4 to 6 in. uniform thickness; for sand-clay, shale and fine gravel, 8 in. at center, to zero at edge for a width equal to the out to out of shoulders. Parabolic surfaces are to have a rate of slope equivalent to 3/8 in. in 12 in., shoulders to be constructed of selected local material such as sand-clay or topsoil, and have a slope of 1/2 in. in 12. They may be sodded or grassed in which case a slope of 1 in. in 12 in. will be satisfactory. The surfacing material is to be the best available local material, including sand-clay, topsoil, gravel, chert, shale, slag, stone screenings, crushed stone, marl, limerock and sandstone. Where local materials are not available in sufficient quantity and at low cost, a study of conditions should be made to design an adequate surface at a reasonable cost. The use of low-cost bituminous surfaces or the oiling or processing of roads may be considered where suitable local materials are not available for untreated surfaces. Under certain conditions the use of single-track concrete or other high-type surfacing may be considered. Present experiments in soil stabilization appear likely to result in useful developments in low-cost surfacing.

Drainage—Provision should be made for intercepting ditches outside the tops of cuts in rolling and mountainous country and for drainage ditches in flat country. Roadway ditches or gutters should have sufficient slope to carry the runoff; however, the slope should not be so steep as to result in erosion. Erosion may be prevented, however, by placing in the ditches low-cost walls of stone or timber to reduce the velocity of flow. The flow line of ditches should not be higher than the low point of the adjacent subgrade. In certain cases underdrains may be needed to carry free water from beneath a roadway.

Pipe Culverts—Pipe culverts should be tion crosses natural drainage and the need for a larger culvert or bridge is not indicated. Pipe culverts should be of ample length and are usually constructed with headwalls of stone or concrete. They should be spaced at shorter intervals in hilly and mountainous country than in flat and rolling country. Pipe culverts may be of galvanized corrugated metal, reinforced concrete, cast iron or vitrified clay.

Structures—Culverts 20 ft. and under in span should have a roadway width of structure equal to the full width of the traveled roadway. They should be of the box-culvert type. For low initial cost creosoted timber culverts are recommended. Where foundations are suitable, with no probability of erosion or scour, a slab culvert may be used without a floor; in general, however, floors are desirable. Where a need for bearing piles to support the structure is evident they should be used without question.

Bridges over 20 ft. in span, should have roadway widths of 12 ft. minimum for single track and 18 ft. minimum for double track. The substructure may be of creosoted timber piles, reinforced concrete piles, plain or reinforced concrete or stone masonry. The superstructure may be of creosoted stringers and wood or reinforced-concrete floor, steel beams or reinforced-concrete beams supporting a reinforced-concrete floor. Creosoted timber stringers may be used in single or multiple span structures in spans of about 26 ft. Reinforced-concrete slab-and-girder construction is considered suitable for single spans up to about 40 ft. Steel beams are suitable for single spans up to 80 or 90 ft. and steel trusses are recommended for single spans over 80 or 100 ft. in length. Wherever feasible the trestle type of construction using treated-timber piling with multiple spans of creosoted stringers and timber or concrete floor, or steel beams and concrete floor is recommended.

Maintenance—Provision should be made for adequate maintenance of surfacing, shoulders, slopes, ditches and structures; maintenance should begin as soon as construction is completed. The untreated roadway surfaces recommended must be well maintained for satisfactory results. If dust and loss of surfacing material become excessive then the untreated surfaces should be improved by one of the several satisfactory types of low-cost bituminous surfaces. Deliquescent salts such as calcium chloride and sodium chloride are useful for this purpose in areas of average or high humidity.

This is the last of a series of articles on current highway problems which have been appearing weekly in Engineering News-Record since Oct. 1, 1936.

Letters to the Editor

Cotton Sheeting in Roadbuilding

Sir—The article "Firming Up Soft Shoulders with Cotton," in your issue of November 26, 1936, is very interesting. There is no question as to the benefits and results to be obtained from the proper use of muslin in roadbuilding, but I fear, from personal experience, in the use of cotton fabrics for roof repairs and membrane waterproofing, that several important items have been overlooked, due to lack of experience or desire for initial saving in cost. These may be summed up as follows:

1. The fabric was evidently used as it came from the mill, with the sizing neither softened nor removed from the threads in the sheeting. Consequently the efficiency of absorptive properties of the preservative materials has been lowered. Best results are obtained by soaking the sheeting in water for at least 24 hr. and applying the preservative while still wet, and then applying the preservative on top before the water leaves the threads. This practice has always resulted in a better penetration of preservatives to the cotton fiber.

2. The fact that any fabric, especially cotton, tends to continue to shrink and the fact that bituminous coatings used in roadbuilding are very susceptible to expansion and contraction, seems to have been ignored. Cotton has practically no elasticity, but tends to shrink continuously and the breaking of any thread will gradually spread to a larger opening through placing of undue stress on the neighboring threads. Fabric should be set to compensate for any differences in movements of materials or it will lose its effectiveness for any purpose.

Louis Deck, Jr.

Woodside, L. I.,
Nov. 30, 1936.

The Iseran Pass Road

Sir: A news item in the issue of October 18, page 562, states that the road over the Iseran Pass is the highest in Europe and is in Italy. This is in error in both instances. The Iseran Pass is in France; it is very close to the boundary between the two countries but is still in France.

The route over the Iseran Pass is the highest in France but not in Europe. Stelvia Pass in Italy is, I believe, the highest automobile road in Europe.

Robert J. Smith

Biloxi, Miss.
October 26, 1936.

Slope Chaining

Sir: I have just finished checking my article, "Slope Chaining in the Mountains," in the October 22 issue of *Engineering News-Record.*

The formula for the correction is in error as printed. As this formula is printed it is

$$c - a = (\textit{per cent of slope})^2$$

whereas it should be

$$c - a = \frac{(\textit{per cent of slope})^2}{100}$$

I use per cent of slope in the sense of rise or fall in feet for 100 feet of line.

A. M. Ockerblad

Lawrence, Kansas
October 31, 1936.

Concrete Bridge Costs

Sir—In ENR Nov. 5, 1936, p. 637 describing concrete bridges being built in western Washington, you point out that: "The $2.46 per sq. ft. of roadway surface is believed to be a low record for reinforced concrete structures of this type, with 40 to 60 ft. spans.

May I note that a number of reinforced concrete continuous rigid frame bridges were designed by me, nearly ten years ago, the costs of which were lower than $2.46 per sq. ft. Among those I wish to mention: Monroe, Wis., grade separation, built 1927, length 113 ft., spans 30-40-30 ft., width of roadway 30 ft., two 5 ft. sidewalks, ornamental concrete handrail, contract price $9,500, cost per sq. ft. $2.10. Kansasville, Wis., grade separation, built 1928, length 227 ft., 29-deg. skew, spans 55.75-68.25-55.75-43.25 ft., concrete posts and pipe handrail, contract price $14,800, cost per sq. ft. of roadway $2.42. New Holstein, Wis., grade separation, built 1927, length 140 ft., [illegible]-deg. skew, spans 3x40 ft., width of roadway 27 ft., concrete posts and pipe handrail, contract price $9,300, cost per sq. ft. of roadway $2.46.

If the high concrete prices at that time and the handrail items would be reduced for comparison with the larger yardage and wooden handrails of the Buckley Bridge, the price differences would be larger. The economy of these structures was primarily the result of placing the main frames, or girders, about 12 ft. apart and using two-way reinforced floor slabs with about 12 ft. sq. bays in which the specified slab thickness could be utilized to maximum advantage. This wide spacing which was more than twice that customary in those days favorably affected the yardage and formwork. The double role of the cross beams as slab supports and transverse distributors of the load among the main frames, or girders, also contributed to economy. The advantages of such bridge floor layouts were pointed out in the European literature two years after these structures were built.

I think that these structures were the first rigid frame bridges continuous over more than two spans built in this country which were designed by a rigorous analysis of the frames, slabs and cross beams distributing effects. I designed these structures in the employ of the Chicago, Milwaukee, St. Paul & Pacific R. R. Co. C. N. Bainbridge was at the head of the design office at that time.

New York, N. Y.
Nov. 19, 1936.

Louis Balog,
Assistant Engineer,
U. S. Flood Control Design Office.

Sutro Weir Formula

Sir—In the Nov. 12 issue there appeared an article by Messrs. Soucek, Howe and Mavis entitled "Sutro Weir Investigations Furnish Discharge Coefficients" in which reference is made to my communication to *Engineering News* of Aug. 27, 1914, giving in detail the derivation of the equation for the Sutro weir.

The discharge formula, however, has been incorrectly printed in the Nov. 12 article, where the discharge is shown as being proportional to the square root of the head above the datum line, instead of directly proportional to this head. This is undoubtedly a typographical error. The discharge equation should of course read as follows:

$$Q = ca^{\frac{1}{2}}b\sqrt{2g}\,(h - a/3)$$

This correction in the formula should be recorded.

E. A. Pratt

Philadelphia, Pa.
Nov. 16, 1936.

Cloudburst Flood Formula

Sir—My article "New Cloudburst Flood Formula," published in *Engineering News-Record* of Oct. 1, 1936, p. 474 was criticized in your issue of Nov. 5, by Messrs. J. W. Pritchett and G. C. Commons of the Texas Board of Water Engineers.

I stated explicitly in my article that the formula proposed "is primarily for watersheds from *about* 1 to 70 sq. mi." Therefore the Texas flood data adduced by Messrs. Pritchett and Commons do not appear quite pertinent, since practically all of them refer to watersheds of 75 to 4004 sq. mi. and no one of them is for less than 61 sq. mi.

The Jarvis table was referred to in my study as well as many other compilations which could not be mentioned in the brief note accompanying my table. The alleged "omission" of fourteen Jarvis items is accounted for as follows: Four of these items, namely, Jarvis *7*, *41*, *271* and *493*, do appear in my table as items 2, 5, 20 and 21 respectively, (by the way, item Jarvis-7 identical with my item 2, Honey Creek, was erroneously plotted on the Pritchett-Commons' graph,—and the error is not in my favor); eight others are outside of the range of my formula (See paragraph 4, p. 475), while on the remaining two items I used some discretionary power—and discretion is quite indispensable in such matters, as I will presently demonstrate.

Of the Texas records tabulated by Messrs. Pritchett and Commons some (for year 1935) are published for the first time and practically all the others had been heretofore published in non-usable form, namely without drainage-area figures.

At first sight the Texas records produce the overwhelming impression that everybody is out of step but Texas. But the impression loses force when one notices that in the Guadalupe River flood of July 1, 1932, the peak discharge at Ingram (drainage area 371 sq. mi.), was 206,000 sec.-ft., but after being increased to about 344,000 sec.-ft., by the recorded inflow of 138,000 sec.-ft. from Johnson Creek, it reached Kerrville (drainage area 570 sq. mi.) with only 196,000 sec.-ft. In other words, in spite of a great increase in drainage area, the river apparently *lost* not less than 148,000 sec.-ft., within probably one hour or so, in the stretch of 7 or 8 miles between Ingram and Kerrville. Similar discrepancies, will be observed between Kerrville and Comfort. (At Comfort there was a permanent gaging station but its records above 3,000 sec.-ft. are admittedly poor. See Water Supply Paper 733, p. 77). Again in the West Nueces River flood of June 14, 1935, the peak above Brackettville (drainage area 402 sq. mi.) was 612,000 sec.-ft. while near Cline, some 25 mi. downstream, (drainage area 880 sq. mi.) the flow was only 536,000 sec.-ft. Of course such records are sorely in need of explanation, and as long as they have not been explained discretionary powers must be used with regard to them.

I do not know how serious Messrs. Pritchett and Commons are in suggesting one single formula $q = \dfrac{600{,}000}{37 + A}$ for both small and large watersheds, but of course this formula will give such absurd values as 16,000 sec.-ft. per sq. mi. for a watershed of 3 sq. mi., 10,000 sec.-ft. per sq. mi. for one of 23 sq. mi., etc. The Texas records, if at all acceptable, suggest an entirely different line running approximately from point 11 (Texas) to 7 (Jarvis), which would also give incredible values, but at the other end, something like 1,200 sec.-ft. per sq. mi. for a watershed of 1,000 sq. mi.

Numerous supplementary data from tropical India, England and New York, recently studied by me, have added greatly to the support of my formula, and, naturally, my confidence in its safety has increased in proportion.

New York, N. Y.
Nov. 16, 1936.

I. GUTMANN,
Associate Editor, The Engineering Index.

Heavy Bridge Traffic in Seattle

Editor, *Engineering News-Record.*

Sir—The vehicular traffic across New York's George Washington Memorial Bridge, in (*ENR*, Nov. 19, 1936, p. 713) invites comparison with a record of like traffic across one of our local bridges. This structure, a six lane, cantilever bridge across Lake Union in Seattle, by a strange lack of originality in nomenclature, bears exactly the same title as the New York structure, to-wit, the George Washington Memorial Bridge, and, similarly, it has been in service about the same length of time—probably a few months less. Per estimate of our city traffic engineer, J. W. Bollong, the number of vehicles crossing this bridge during the current year will approximate 9,500,000 or practically 25,000 per day as compared with the current year average for the New York bridge of only 19,000 per day. Apparently, our bridge crossings per capita of tributary population appreciably exceeds that of New York.

JOSEPH JACOBS,
Consulting Engineer.

Seattle, Wash.
Nov. 25, 1936.

ALTHOUGH TRAFFIC volume on Seattle's Lake Union bridge exceeds that on New York's Hudson River bridge, the latter structure is not a New York City bridge in the sense that the four East River Bridges are. Latest figures for daily traffic volume on these bridges are: Brooklyn, 25,000; Manhattan, 88,500; Williamsburg, 48,000, and Queensboro, 84,000. The Queensboro traffic is considerably reduced over past years because the roadway is being reconstructed and perhaps because of the new Triborough Bridge. Last year Queensboro Bridge Traffic averaged 98,000 vehicles per day and in 1934 the average was 103,000.

—EDITOR.

Computing Volumes in Intersecting Arches

Sir: In the Oct. 8, 1936, issue of *Engineering News-Record* is an interesting short article by Louis J. Sack on the computing of volumes in intersecting arches.

The computation of the volume of groined arch vaulting is not difficult provided certain assumptions are made, for example, if the intrados of the arch is taken as semi-elliptical or semi-circular and the extrados as a parabola or a straight line.

When the late W. B. Fuller and the writer were respectively resident engineer and assistant engineer on the design and construction of the Albany, N. Y., water filtration plant (the slow sand filtration plant) in 1898 they worked out a few basic formulas for determining the volume of groined arch vaulting. One of these basic formulas is given by Mr. Fuller in *Transactions, Am. Soc. C. E.*, Vol. XLIII, 1900, p. 65. These few basic formulas were later very considerably expanded by the writer, and the writer subsequently plotted a diagram for certain types of groined arches, from which the volume of semi-elliptical groined arch vaulting could be readily obtained. This diagram was published in an article by the writer entitled "Diagram for Determining the Volume of Semi-Elliptical Groined Arch Vaulting," *Engineering News*, Vol. 44, Aug. 23, 1900, p. 130; and it also appeared in an article entitled "Notes on Designing and Constructing Slow Sand Filters" by the late James H. Fuertes, *Engineering Record*, Vol. 43, Feb. 2, 1901, p. 100.

Reference might also be made to a paper entitled "The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume" by the late Leonard Metcalf, *Transactions, Am. Soc. C. E.*, Vol. XLIII, 1900, p. 38, in which Mr. Metcalf derived formulas for determining the volume of certain types of groined arches. (It was in a discussion of this paper that Mr. Fuller presented some of the formulas worked out at Albany.) Further, some of the formulas worked out by Mr. Fuller and the writer were included in an article entitled "The Groined Arch in Filter and Covered Reservoir Construction," by Thomas H. Wiggin, *Engineering News*, Vol. 63, April 7, 1910, p. 398, and also in a paper entitled "The Comparison of Concrete Groined Arches as an Aid in Their Design," by Philip O. Macqueen, *Transactions, Am. Soc. C. E.*, Vol. LXXXVI, 1923, p. 180. Also mention might be made of an article entitled "Volumes at Jack-Arch Groins," by George Paaswell, *Engineering News-Record*, Vol. 89, Dec. 14, 1922, p. 1,024 and July 3, 1924, p. 28.

JOHN H. GREGORY,
Consulting Engineer.

Baltimore, Md.
Oct. 12, 1936

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Editorial Offices at 330 West 42d Street, New York
December 24, 1936

Rising Prices

BID FIGURES on the iron and steel lining for the second tube of the Midtown Tunnel at New York proved to be 35 per cent higher than the price bid for the iron of the first tube, three years ago. The comparison reflects—qualitatively at least—the general rise in cost of essential construction materials that has been in progress for some time and is still continuing. The same rise is expressed also in higher lumber prices and in the numerous recent contract bids that exceeded the estimate, some of which necessitated redesigning the work in order to fit appropriations. There is little question but that the change is mainly a result of higher production costs, and since the factors that tend to increase costs are still active it is reasonable to look for further increase. Construction costs in 1937, therefore, are likely to be well above 1936 levels. Works directors and other planning authorities will be well advised to look to their budgets.

Difficult Job Well Done

FOR YEARS Syracuse presented the incongrouous spectacle of the country's finest and fastest trains crawling through active business streets. At all hours of the day, ponderous locomotives poked their noses into the snarled traffic of a busy city. But no longer does the *Twentieth Century* or the *Empire State Express* dispute the right-of-way with taxis and trucks; after 38 years of agitation the old condition has at last been changed, and today the trains of the railroad concerned run over a five-mile three-track elevated line. It was a tough job to get the trains off the streets—a tough job in planning, design and construction. Planning was complicated by many conflicting desires; but it is interesting to note that though every other plan presented was studied carefully the final scheme follows closely that laid down in 1898. Design problems were many: first, to provide foundations in swampy ground, where piles either took up too short to give the necessary lateral stability or else dropped out of sight in bottomless muck; second, to limit the width of costly right-of-way by extensive retaining-wall construction; and third to attain an aesthetically acceptable result. Coordination of the construction work in congested city surroundings was no less difficult. The discouraging tendency of high fills to slump into mucky ground created further problems that called for high skill in engineering and construction. As a whole the Syracuse improvement is a monument to modern progress and an achievement in which all who had a hand in it may take pride.

Shades of the Past

INCIDENTALLY, no vestige of old-time railroad depot conditions survives in the new Syracuse passenger station built in connection with the track elevation just completed in that city. Gone are the cold and forbidding surroundings that characterized the nineteenth-century railroad station, gone are the hard, spine-racking benches flanked by baggage that was ever a stumbling block in the narrow aislé. Instead, the bewildered traveler finds groups of comfortable red leather chairs and divans, with rugs on the floor and inviting writing desks scattered throughout a beautiful waiting room. He approaches the ticket window with timidity, not knowing whether to ask for transportation or a room and bath, for the station appointments are more in keeping with a modern hotel lobby. Shades of the past! The railroad station of 1936, typified at Syracuse, is a genuine convenience to the traveling public; no longer is it merely a masonry box that marks the point for trains to stop.

A Matter of Policy

AS THIS IS WRITTEN the pros and cons of the Florida ship canal are being considered by the Board of Engineers for Rivers and Harbors. Though the proponents of the canal have set forth in impressive figures the supposed benefits of the proposed waterway it seems evident that most of the benefits are intangibles (upon which it is so easy to set high values) rather than benefits for which ship lines are willing to pay tolls. Under such circumstances, as we stated in our issue of Dec. 3, proper functioning of the system under which the Board of Engineers for Rivers and Harbors was set up seems to call for an adverse report by the board unless it finds definite proof of economic soundness. After such report is made Congress might still decide to build the canal if, in the opinion of Congress, it is good public policy to do so in order to make work in a region where work still is scarce—or even on the ground that the intangible benefits of the canal in reduced risk and improved coast-wide shipping justify the large expenditure involved. Little objection could be raised to such a finding; but emphasis must be laid on the point that such a finding should be made by Congress, not by the Corps of Engineers, because policy, not a weighing of cost against measurable return, is involved. The army engineers' function in a matter of this kind is only that of analyzing facts; it is for Congress to determine policy. If the present system is to continue to serve a useful purpose this distinction must be maintained, and no amount of outside pressure should be permitted to force the army engineers into making a favorable report on the broad general ground that it is "justified in the public interest" when there is no clear showing of economic advantage.

Regional Sewage Treatment

THE MOGDEN SEWAGE DISPOSAL PLANT recently placed in operation in the greater London area of England has many features which recommend it for study by American sanitary engineers. Of paramount importance is the conception of the scheme, which bases on centralization of treatment in a single plant serving 16 municipalities, with heretofore 28 separate disposal plants. The economic advantages of the cooperative undertaking are evidenced in many ways. The $27,100,000 project, half of which was paid for by the government, is being financed by a tax of $2.40 per $100 levied on the district. This tax, less than what many communities previously paid for sewage disposal, covers loan charges, operating costs, payment of existing loans on plants that have been superseded, demolition of these plants, and compensation to the discharged workers who operated them. In addition to other economic benefits the abandonment of the 28 plants has restored to other uses about 1,000 acres of valuable land. The design features of the Mogden plant, described in this issue, also deserve attention. The merit of the centralized system in providing better treatment facilities at lower cost commends it for consideration in regional improvement planning here as well as in England.

Reform Building Practice Now

EVERYTHING points to an early revival of building, and by all indications it will move ahead vigorously once it gets under way. If the building produces safe and excellent structures it will be a strong force to help restore economic balance. But building is not always well done; it is not even always safe, as proved in sensational manner by a long record of collapse tragedies and less sensationally by the innumerable cases—chiefly in the dwelling house field—of investment destroyed by quick deterioration. The first step to sound building is assurance of safe building. And in view of the approach of a building boom anything that can be done to make building unquestionably safe ought to be done promptly.

That architectural and engineering skill is the first need of good building is well enough known to need no restatement. Yet the fact is that a great deal of building goes on with only minor participation by engineer or architect. To improve building, then, let us reform our procedure so that the technical competence of these professional men will be in responsible charge of all building operations.

It happens, unfortunately, that most of our building laws look to the owner as the one to assure the quality and safety of the building operation. The owner receives the permit, and the owner is looked to by the public building supervision for observance of law and safety requirements. This system only too often brings disappointing results. The owner is ignorant of building, and his pocketbook tends to speak louder than his conscience. He feels that the building law is too stringent, and wherever he can he seeks to "get by." Lacking all technical knowledge, and not having the professional adviser's sense of responsibility, his attitude is not unnatural.

Stricter building laws and more rigid supervision are not the answer to this difficulty. Nothing is to be gained by making building laws oppressive; some of them are already too severe. Complicated detailed specifications and requirements are by no means a secure road to sound building, and arbitrary regulation is a poor substitute for technical competence and professional responsibility. The essential need is that building laws be modernized to require technical design and supervision by architects or engineers of known competence. This single change would at one stroke accomplish a fundamental improvement, assuring both the skill and the sense of professional responsibility vital to all construction.

Professional control of building is already being considered. It was recommended ten years ago by a joint committee of architects and engineers, who urged that professional design and supervision of construction be made a mandatory requirement and that the supervisor attest the safety of the completed structure as a condition precedent to issuance of an occupancy permit by the city. A discussion of this method of building control in comparison with others that have been proposed may be found in "Better Building Construction" (*ENR*, May 13, 1936, p. 758).

Whether such requirements as to building should be applied to small-house construction at this time is open to question. The modified method of introducing professional skill into housebuilding that is being advocated by the Home Owners' Loan Corp. may be a better answer. But whatever may prove to be effective to assure building quality in the small-house field, the case of major structures—apartment and commercial buildings, warehouses and theaters—is clear. Only through insistence on responsible professional participation in every operation can we hope to assure safe results.

Prophetic Views

THE SERIES OF TWELVE articles on current highway problems concluded in this issue lays emphasis on creative vision in road engineering rather than on present accomplishment. A wide range of road problems has been dealt with in the series—administration, road service and operating requirements, discussed in courageous and thoughtful manner by men of authoritative standing in roadbuilding and highway transport. Yet even with this favorable background the reader may fairly ask: What end has been reached in these discussions? What do they teach of the work ahead?

Those who look for a quantitative answer will not find it. No definitive conclusion is reached on taxation, on arterial roads or on any of the half-score other subjects that are considered. The prime importance of the discussion is the proof that it gives of creative highway thinking. The contributors all agree in basing their thinking on highway transport as the objective to be served, not on roadbuilding. This attitude is as plain in the discussion of intersection design as in the appraisal of arterial or express highway systems.

Keyed to this view of the road as the servant of transport is the bold conception of the future main road as a freeway. The new conception applies not merely to the superhighway, the intercity arterial and the long-distance express road but is held to have increasing significance also for the common-service main road. Here is a second lesson, and it is a vital lesson for highway engineers to master.

Though the modern motor vehicle makes possible the greatest diffusion of fast transport that man has ever known, this possibility cannot be utilized fully by the transport engineer because of the limitations of the road. The road lacks the essential service qualities of the freeway, and each year, as it is extended to more and further termini, this lack becomes more serious in its effects. In large degree this can be overcome.

It is in ideas and vision that the twelve articles completed this week make their major contribution to highway planning and administration. The road planner and builder has seen his problems discussed in their bearing on efficiency of transport development, whether the immediate subject was taxation, system planning or merely the design of road crossings or farm-to-market roadways. All these problems must continue to be faced with even more forward-looking courage if tomorrow's roads are to serve public transportation well.

CURRENT NEWS

White River Plant To Get License

License conditional on redesign of the dam to facilitate use of the river for commerce and pleasure

The Federal Power Commission on Dec. 16 announced the authorization of a license to the White River Power Co. for construction of a hydro-electric plant with an ultimate capacity of 102,000 hp. at Wildcat Bend on the White River in Baxter and Marion counties, Arkansas. The White River Power Co. is a subsidiary of the Arkansas Power & Light Co., which is an affiliate of the Electric Bond & Share Co.

The actual license for the project will be issued only if the dam is redesigned to meet conditions set up in a report made by the War Department to the Federal Power Commission. Plans for the redesign are required to be submitted to the Commission on or before June 1, 1937 and must be opposed by the Chief of Engineers and the Secretary of War.

Among the special conditions imposed are that the licensee shall construct, maintain and operate at its own expense means for passing rafts and floatable commodities over the dam free of charge and shall reassemble the rafts passed over the dam without expense to the owners; shall construct and operate at its own expense means and appliances other than locks for passing in both directions boats of the sizes suitable for use on the river whenever navigation on the White River requires the installation of such facilities; shall so operate its project that the discharge in the river immediately below the dam shall be not less than 800 acre-ft. of water per day except when the flow available at the dam is less than that amount; shall cut and remove all brush and trees within and adjacent to the area to be submerged; shall permit free use of the reservoir by the public for navigation or recreational purposes and allow the construction of wharves and landings not inconsistent with the operation of the project; shall construct and operate such fishways as may be prescribed by the Secretary of Commerce or, if he shall not prescribe such fishways, the licensee shall construct and maintain such fish hatcheries as may be required by the state of Arkansas; finally the licensee is required to control mosquito propagation in the shallow portions of the reservoir in such manner as may be directed by the power commission on the state board of health of Arkansas.

The dam, reservoir, power plant and auxiliary structures authorized at Wildcat Bend are to be constructed in two steps. The first step, which must be completed within 4½ years after the date of issuance of the license, consists of a dam and spillway and two generating units having an installed capacity of 38,000 hp. The final step consists of the addition to the spillway of piers and gates 26-ft. deep and installation of a third generating unit, giving a total installed capacity of 102,000 hp. A time limit for the second stage of construction will be set at a later time by the power commission.

The application of the White River Power Co., filed in 1930 and amended in 1934, requested licenses for two other developments on the White River, one at Bull Shoals, 16 miles upstream from Wildcat Bend, and one at Hog Thief Bend, 42.4 miles upstream from Wildcat Bend. The commission held that the company failed to present evidence of engineering or economic feasibility of these two developments and license for them was denied. The original application had asked for a license for projects on the North Fork and Buffalo Fork, but these were dropped from the amended application.

Duke Power Co. Enters Suit Against High Point Plant

The Duke Power Co. of Charlotte, N. C. and J. B. Williamson, a taxpayer, have filed an injunction petition in the North Carolina superior court seeking to prevent the city of High Point, N. C., from building a $5,756,000 power plant for which the PWA recently allotted a grant of $2,595,000 (*ENR*, Nov. 19, 1936, p. 730).

The petition claimed that the project would be in violation of the limitation imposed by the state constitution on municipal indebtedness and that it also represents a violation of the federal constitution's provisions protecting private property.

Award by Lot Required On Identical Federal Bids

Acting Comptroller Elliott has ruled that in cases of identical bids on government purchase contracts determination of the award must be made by lot. Heretofore, it has been the practice of the Department of the Interior and of the Public Works Administration in such cases to award the contract to the person or firms located farthest from the point of delivery. This policy was adopted as a punitive measure "because of the persistent failure of bidders to submit bids on a competitive basis."

The Comptroller General's office bases its decision on Section 3709, revised statutes, which specifies that in cases of identical low bids the procedure of awarding by lot must be followed. Although this regulation has been modified by rulings permitting local bidders to be favored in cases where more rapid delivery would result, it is held that no justification is found for any other departure from the law. Comptroller Elliott's action followed a complaint brought by the Rocky Mountain Architects and Builders Service, Denver, Colo., and by the Colorado Fuel & Iron Corporation. These organizations argued that the existing practice made it impossible for them to hope for steel orders from western reclamation projects undertaken by the federal government.

Sidewalks Asked For N. Y. Highways

Traffic commission proposes legislation for highway department to build sidewalks on rural roads

The New York State Traffic Commission, a regulatory traffic control body created by the 1936 legislature, has recommended the construction of sidewalks along state highways through congested sections in the state where cities and villages have not provided such facilities.

The recommendation has been made as a safety measure to eliminate the possibility of accidents to pedestrians in the region of cities and villages. New York highway officials have long recognized the need for pedestrian walks, particularly just outside of cities and villages, but have been unable to do anything about the problem because of legal restrictions limiting the use of highway appropriations to construction of highways and bridges, leaving the construction of walks to the towns or counties. Attempts to meet the problem by widening highway shoulders have not been entirely successful since it has been found that pedestrians tend to walk on the pavement rather than on the shoulders which are provided.

Legislation will be required to put the commission's recommendation in effect. The recommendation will be submitted to the 1937 legislature with a request that the law be amended and an annual appropriation be made for sidewalk work under state direction. It is estimated that the division of highways would require about $3,000,000 to provide such pedestrian facilities.

Schenectady Housing Project To Be Redesigned

Redesign of Schonowee Village, $1,500,000 PWA slum clearance project in Schenectady, N. Y., has been ordered by Administrator Ickes, upon recommendation of the PWA Housing Division. The plan will be so changed as to increase the number of apartments and thus achieve a more economical type of building.

Bids for construction of the buildings for the project were rejected by the PWA after their opening on Oct. 1 on the grounds that they were too high. At that time a restudy of the project to determine whether the cost could be lowered was ordered.

Under the revised plan the number of apartments will be increased from 208 to 219. The original plan for the use of two-story flats was discarded and, in the new arrangement, the 219 units will be divided among five groups of three-story apartment buildings.

The buildings in the project will be of fireproof brick and concrete construction and will be heated from group heating units.

Bids will be called as soon as the detailed plans are completed.

McLaughlin Aerial Surveys

WHERE THE GOLD IS KEPT

What you can see in this picture is all you are ever likely to know about the Treasury's new gold vault in Kentucky. Its details, for obvious reasons, are shrouded in secrecy and guarded by the soldiers of nearby Fort Knox, Ky. The vault is not open to visitors.

Shore and Beach Association Discusses Federal Aid

Emphasis at the Dec. 14 meeting of the American Shore and Beach Preservation Association in Washington, D. C., was placed upon the question of what form federal aid to beach protection work should take under the new federal beach protection act.

In particular, Col. Earl I. Brown, chairman of the United States Beach Erosion Board, stated that the board was having difficulty in devising a yardstick to measure the amount of federal interest in different beaches. The law passed by Congress last June made it the policy of the federal government to provide financial assistance for beach preservation based on the federal interest in the beaches. Colonel Brown stated that the board has found that the only federal interests are in providing recreation, protection for taxable property, and protection for the lives of citizens. He said that the board would welcome suggestions from local bodies as to how to go about measuring this interest.

He also said that it would help if communities making application for surveys by the board would make preliminary surveys and submit outlines of the engineering needs and a statement of the number of people who use the beach, of where they live, and any other data that might prove helpful to the board.

A message from Brig.-Gen. Max Tyler pledged the cooperation of the Corps of Engineers in the work of the association. Other speakers urged the association to work for state action to obtain title to ocean front land and for broader federal legislation for shore protection than now exists.

J. Spencer Smith, president of the association and of the New Jersey State Board of Commerce and Navigation, stated in his annual address that there was growing dissatisfaction with private ownership of beaches and that the association must be prepared to consider the question of private versus public ownership.

Charles Warner, president of the board of harbor commissioners of Wilmington, Del., was elected a director of the association to fill the place of the late Willard A. Speakman.

◆

Local Debt Increase Slight During the Depression Years

State and local debts in the United States increased only 9.1 per cent between the fiscal year 1930 and the fiscal year 1936, according to figures released by the National Industrial Conference Board. During this same period the debt of the federal government increased 108.7 per cent.

In the fiscal year 1930 the state and local debt amounted to $17,985,000,000. It increased slightly for two years, reaching a total of $19,635,000,000 in 1932, and it declined in 1934 to $18,942,000,000. Another gradual upward trend then set in, and state and local debt rose to $19,277,000,000 in 1935, and to an estimated $19,621,000,000 in 1936. Meanwhile, the debt of the federal government increased steadily from $16,185,000,000 in 1930 to $33,779,000,000 in 1936.

The most important reason for the relatively small change in state and local debts, in the opinion of the board, lies in the fact that the fiscal position of many governments was such that their credit rating was seriously impaired. From this arose the necessity of drawing on the federal credit for financing of projects ordinarily financed from the proceeds of local bond sales. In addition, the federal government increased its allotment to the states for highway purposes.

Denver Asks Bids On Water Tunnel

Water from three-mile tunnel under the Continental Divide will dilute Denver's sewage.

Bids on driving a three-mile water diversion tunnel through the Continental Divide were called for by the City of Denver on Dec. 17. The tunnel, which is to run under James Pass, about 60 miles west of Denver, will be of horseshoe section about 8 x 9 ft., 15,590 ft. long, with a concrete paved invert throughout its entire length. Water from the Williamsport River on the western slope will be diverted through the tunnel to dilute the effluent from the new city sewage disposal plant.

The elevation of the west end of the tunnel is 10,400 ft. and of the east end 10,312 ft. The water will be gathered, without impounding works, by a series of canals on the western slope, and will flow directly into the tunnel. From the east portal it will flow into West Clear Creek, White Cap Ditch, and the Platte River.

The estimated cost of excavating and paving the tunnel, $732,000, will be paid out of a fund which was raised by a bond issue and PWA grant more than a year ago to be used at the discretion of the city engineers for a sewage disposal plant. The plant itself, located in the city limits, is now about one-third completed. The estimated cost of the entire project is $1,200,000, including a 45 per cent PWA grant.

The necessity for the tunnel arises from the fact that Denver's sewage effluent constitutes 21 per cent of the normal flow of the South Platte River below Denver (*ENR* Oct. 15, 1936, p. 535). It was determined that the state requirement that the pollution should not exceed 40 parts per million B.O.D. could be met if an average of 12,000 acre-ft. of dilution water were added to the normal river flow. It is estimated that the construction of the tunnel will provide an additional 20,000 to 25,000 acre-ft. of water.

◆

Bayonne Terminal Contract Voided by State Court

The New Jersey Supreme Court on Dec. 19 set aside a contract between the city of Bayonne; the Central District, Inc., an agency of the city; and the Central Railroad of New Jersey, which provided for the construction of a $5,000,000 ship-to-rail terminal extending from the Bayonne shore into New York Bay and, the court held, gave exclusive rights in the terminal to the Central Railroad of New Jersey.

In the same decision the court expressed surprise that the PWA should have made a $2,252,000 grant for a "tidewater terminal tied up for all transportation purposes to a railroad company enjoying monopoly rights therein."

The court held that the agreement did not come within the scope of an act of 1920 authorizing construction of the terminal and permitting the city to acquire lands and easements in fee simple and not otherwise.

The Bayonne City Commission has announced that it would consider very shortly the preparation of a new contract meeting the objections of the court.

Federal Aid Asked For City Airports

Washington Correspondence

Many municipal airports which are losing money are backing a bill to be presented in the next Congress appropriating ten or twenty million dollars to be matched with local funds to modernize scheduled airway ports and, later, other airports. The legislation is sponsored by the American Municipal Association.

The sponsors of the bill argue that 90 per cent of air traffic is interstate; that an airway system is no safer than its most dangerous airport and that correction of airport dangers is imperative; that work to be done on several hundred airports will increase employment; that the military air forces depend largely on commercial and civil airports and that therefore improvements will contribute to national defense. They cite as precedent the subsidies now being given for rivers and harbors, highways and railroads.

Very little opposition is expected to the bill except from the railroads, which have already lost 5 per cent of their Pullman-class business to the airlines and will lose 25 per cent of it in ten years, if the present rate continues.

The Bureau of Air Commerce, which is in full sympathy and cooperation with the municipal association, does not feel that the $25,000,000 spent on 1,200 airport projects under the CWA and FERA in 1933 and 1934 was wasted. The airports, though on leased grounds, were improved with benefit to aviation, badly needed employment was made, and when WPA was instituted over 100 municipalities bought the land. The present WPA program, which is 70 per cent complete, will spend $15,000,000 more.

◆

Car Tracks Ordered Removed From Chicago Lake Shore Drive

After twelve years illegal occupancy of the Lake Shore Drive, tracks laid by the Chicago Surface Lines for temporary use have been ordered removed. The Illinois Commerce Commission could not find that the tracks served any public convenience or necessity.

In 1921 the street car company was given a temporary permit to install tracks crossing the Lake Shore Drive at Chicago Ave. and paralleling the Drive between Chicago and Grand Aves. for the purpose of carrying passengers to a Pageant of Progress held on the Municipal Pier. This was in addition to a line running directly to the pier in Grand Ave., three blocks to the south. In 1924, after the pageant closed, the Lincoln Park Board sought to have the tracks removed from the boulevard, but the street car company was able to make its temporary permit hold despite small use by the public of the facility. In 1932 the commission ordered the tracks removed and plans for relocation along the drive to be prepared. Appeal from this decision by the Lincoln Park Board to the Superior Court was made and is still pending but this year the Chicago Park Board took over functions of the Lincoln Park Board and filed a new petition with the commission, now favorably acted upon.

The principal significance of the decision is that it frees the drive of a serious obstruction and bottleneck at the north end of the approach to the nearly completed Outer Drive Bridge, a link between the north and south side park systems.

◆

Relate Reclamation to Use of Water and Land

At the meeting of the National Reclamation Association at Spokane Nov. 23 to 24, the principal subject was the relation of reclamation to national water and land-use policies. President O. S. Warden's address emphasized this theme, and it was again brought out in later discussion during the meeting. Senator William E. Borah, Idaho, and Senator Lewis Schwellenbach, Washington, in addressing the meeting also dwelt on the place of reclamation in a program to conserve and increase national resources.

With respect to proposals for a continued moratorium on reclamation repayments, the meeting revealed an attitude opposed to a blanket moratorium. John C. Page, Acting Commissioner of Reclamation, warned that it would be anomalous to ask Congress for large additional appropriations for reclamation development while asking for a moratorium, the latter indicating the inability of existing developments to meet their cost.

Plans were laid before the meeting to establish a Washington office of the Association and to engage a full-time secretary, under a budget of some $30,000, with a view to carrying on an educational and informational service. While the plan was approved in principle its execution was deferred pending the development of a financial program by the association's ways and means committee.

O. S. Warden, Helena, Mont., was reelected president of the association, and Louis A. Campbell of Missoula, Mont., was reelected secretary.

◆

D. C. Serber Dies

David C. Serber, civil engineer and contractor, builder of part of the New York City subway system, died on Dec. 16 in New York at the age of 68.

Mr. Serber, a native of Russia, was educated at the University of Kiev and received the degree of civil engineer from Columbia University in 1896. After his graduation, he held various positions in the engineering departments of New York City until 1903 when he became structural engineer for Henry Steers, Inc., construction engineers of New York City, in which position he specialized in river and harbor work. He was with the Steers Co. until 1908. After holding various positions in New York State and California, Mr. Serber organized his own company, D. C. Serber, Inc., in 1912, specializing in subway contracts. This firm built part of the 207th St. section of the 8th Ave. subway and the extension of the B.M.T. 14th St.-Eastern subway line from 6th to 8th Aves. He also built stations on Broadway and in Brooklyn for the 4th Ave. line of the B.M.T.

Mr. Serber wrote "The Analysis of the Design of Retaining Structures."

Work on Brazos River Dams Limited by an Injunction

The District of Columbia Supreme Court (equivalent to a federal district court) granted on Dec. 19 a preliminary injunction restraining the use of federal funds to construct a series of dams for the Brazos River Conservation and Reclamation District in Texas. The injunction, which was granted at the request of a group of Texas utility companies, will remain in effect until a hearing on March 3, 1937. Under the terms of the injunction a limited amount of construction work will be allowed to proceed on five of the dams.

It is expected that construction will start early in 1937 on the Possum Kingdom dam in Palo Pinto County, Texas, the first of thirteen dams to be built on the Brazos River; the surveys and preliminary field work for this project are nearly completed.

The estimated cost of the several dams, excluding land purchased for reservoir sites, is as follows: Possum Kingdom dam, $3,532,000; Breckenridge dam in Throckmorton county, $3,635,000; Seymour dam, in Stonewall county, $3,509,000; Turkey Creek dam, Palo Pinto county, $2,050,000; Inspiration Point dam, Palo Pinto county, $2,075,000; Cordova Bend dam, Hood county, $2,229,000; Bee Mountain dam, Bosque county, $3,636,000; Whitney dam, Bosque county, $3,648,000; Lampasas dam, Belle county, $1,901,000; Leon dam, Belle county, $2,984,000; Nabasota dam, Brazos county, $2,312,000; North San Gabriel dam, Williamson county, $1,397,000; South San Gabriel dam, Williamson county, $2,016,000.

The entire Brazos River Conservation and Reclamation District has an area of 24,544,000 acres, of which about 3,000,000 are subject to overflow.

Hydroelectric power will be generated, and a tentative contract for its purchase has been made with the Texas Power & Light Company.

◆

No Cause Determined for Washington Viaduct Accident

Further investigation has failed to disclose the cause of the fall of a 2-ton floor beam from the Benning Viaduct in Washington, D. C., which killed John L. McDonald, the contractor (*ENR*, Dec. 10, 1936, p. 838).

Investigation of the cause of the accident is difficult because all of the workers in a position to testify as to what happened are either dead or seriously injured. It appears, however, that the transverse floor beam, which was bolted in place and had been up long enough for the four connecting stringers to be placed, broke loose without warning and dropped, carrying the stringers along with it. No rivets had been driven, and the number of bolts holding the beam is not definitely known. The crane used for steel erection was not attached to the floor beam and apparently was not in use at the time of the accident so that the possibility of any blow or knock against the beam which might have caused it to fall is remote. Erection methods were the same as had been used throughout the work, but the riveting was lagging far behind placement.

SOCIETY CALENDAR

ASSOCIATED EQUIPMENT DISTRIBUTORS, annual meeting, New Orleans, La., Jan. 10-12.

CANADIAN CONSTRUCTION ASSOCIATION, annual convention, Ottawa, Canada, Jan. 11-13.

AMERICAN ROAD BUILDERS ASSOCIATION, convention and highway exhibit, New Orleans, La., Jan. 11-15.

UNIVERSITY OF COLORADO, highway engineering conference, Boulder, Colo., Jan. 14-15.

AMERICAN ENGINEERING COUNCIL, annual assembly, Washington, D. C., Jan. 14-16.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS, annual dinner meeting, New York, N. Y., Jan. 18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, Jan. 20-23.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Montreal, Canada, Jan. 29-30.

AMERICAN CONCRETE INSTITUTE, annual meeting, New York, N. Y., Feb. 23-25.

SOUTH CAROLINA SOCIETY OF ENGINEERS, annual convention, Columbia, S. C., Jan. 7.

NEW JERSEY SOCIETY OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS, annual convention, Paterson, N. J., Jan. 16.

COLORADO SOCIETY OF ENGINEERS, annual meeting, Denver, Colo., Jan. 15-16.

LOUISIANA ENGINEERING SOCIETY, annual meeting, New Orleans, La., Jan. 22-23.

NEW YORK STATE SEWAGE WORKS ASSOCIATION, annual meeting, New York City, Jan. 21-23.

AMERICAN WOOD PRESERVERS ASSOCIATION, annual meeting, New Orleans, La., Jan. 26-28.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Detroit, Mich., Jan. 1-29.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS, annual meeting, New Haven, Conn., Feb. 16-17.

SOUTHWEST ROAD SHOW AND SCHOOL, Wichita, Kansas, Feb. 23-26.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual convention, New York, N. Y., Feb. 24-26.

MINNESOTA FEDERATION OF ARCHITECTURAL AND ENGINEERING SOCIETIES, annual convention, St. Paul, Minn., Feb. 26-27.

LICENSE EXAMINATIONS

MICHIGAN, examination for architects will be held at the University of Michigan and for engineers and surveyors at the University of Michigan, at Michigan State College, at Michigan College of Mines, and at Ironwood, on Dec. 28-30.

◆

Death of Samuel Weiskopf Ends Notable 40-Yr. Career

The death in St. Petersburg, Fla., Dec. 20, of Samuel C. Weiskopf, senior member of the New York consulting firm of Weiskopf & Pickworth, closed a career that for 40 years was closely focused on the development of tall building frames. Graduating from the University of Michigan in 1882, Mr. Weiskopf spent the next decade in the employ first of the Chicago, Milwaukee & St. Paul R. R. and then of the Carnegie Steel Co. In 1895 he opened his own office in New York City, and thereafter played a prominent part in the development of the skyscraper and in the proper design of wind bracing.

Under his own name and under the firm name of Weiskopf & Pickworth, Mr. Weiskopf designed many prominent structures, among them the City Investing Building, Trinity Building, Adams Express Co. Building, Bankers Trust Building, New York Stock Exchange Addition, J. P. Morgan bank, Bank of America, American Telephone & Telegraph Building, American Radiator Building, Daily News Building—all in New York City; Mellon National Bank, Gulf Oil Building, Pittsburgh, Pa., Travelers Insurance Building, Hartford, Conn. In some of these structures unusual problems were encountered, as, for instance, in the American Telephone & Telegraph Building where a number of columns carrying 27 stories were removed in the first floor, the upper 27 being supported by new trusses. In the addition to the Stock Exchange, large trusses were installed on which rested 24 stories of the building, in order to create large open rooms.

In 1925 Mr. Weiskopf was called to Japan to advise Mitsui & Co., on the construction of buildings capable of withstanding earthquake shocks, and prepared designs for the Mitsui main building and four smaller ones.

Mr. Weiskopf was 76 years old. Since his retirement 2 years ago his firm's activities have been carried on by John W. Pickworth, Edward F. Weiskopf and Walter H. Weiskopf.

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Lining Contract Let For Midtown Tunnel

The Port of New York Authority has awarded the contract for manufacture of the cast-iron tunnel lining for the second tube of the Midtown Hudson tunnel to the Bethlehem Steel Co. of Bethlehem, Pa., on its low bid of $3,018,000. At the same time a $2,000 contract for exploratory borings for the New York ventilation shaft was awarded to the Standard Drilling Co. and a contract for a permanent field office on the New Jersey plaza which will serve both tubes was awarded to the low bidder, the George Siegler Co. of Jersey City for $429,568.

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Public Works Association Elects Its First Officers

The result of the balloting of the membership for the election of officers to the new American Public Works Association, recently formed by the merger of the American Society of Municipal Engineers and the International Association of Public Works Officials, was announced on Dec. 14. The following officers were elected to serve from Jan. 1, 1937, until the 1937 convention: president, Thomas Buckley; first vice president, J. E. Root; second vice president, Guy Brown, treasurer, John Flockhart.

◆

Bay Bridge Pays Half Million in 19 Days

Lieut.-Governor Hatfield of California has announced that the San Francisco-Oakland Bay Bridge, during the first 19 days after its opening, from Nov. 12 to Dec. 1, had carried about 660,000 vehicles which paid tolls amounting to about $442,000. The average toll was 67 cents.

Lieut.-Governor Hatfield, who has been an advocate of a 50-cent toll on the bridge, contends that these collection figures, which are greatly in excess of estimates, indicates that the existing toll of 65 cents is too high and should be lowered.

Personals

J. W. Chambers has been appointed assistant bridge engineer of the Alabama Highway Department, succeeding G. P. Willoughby, recently resigned.

Capt. James C. Marshall, district engineer of the Albany district, U. S. Engineers, has been transferred to the office of Major-General Markham, chief engineer, at Washington.

Samuel MacIlwain, D. O. E. Carrier, and H. J. Black, have been appointed division engineers by the Canadian National Ry. with headquarters at Capreal, Ont., Horne Payne, Ont., and Ottawa, Ont., respectively.

Walter B. Anthony, who has been resident engineer on the Winona Dam on the Mississippi River, has been transferred to the first New York district of the U. S. Engineers and is now in charge of the cost estimating department on flood control work for that district.

Harry A. Hageman, formerly hydraulic engineer of the Stone & Webster Engineering Corp., Boston, and lately public building commissioner of Newton, Mass., has been appointed chief hydraulic designing engineer of the Tennessee Valley Authority, reporting to the chief designing engineer, with headquarters at Knoxville, Tenn. His appointment is effective in January.

J. E. Garn has been appointed supervising engineer for the western district of the United States Bureau of Air Commerce and has been given technical supervision over all WPA construction of airports in the western region. Mr. Garn has been regional supervisor and consulting engineer for the bureau, with offices in Salt Lake City, for the past year and before that was district engineer for the Utah State Road Commission.

◆

Obituary

Porter Allen, chief engineer of maintenance of way of the Pennsylvania Railroad's western region, died on Dec. 13 in Winnetka, Ill., at the age of 56. Mr. Allen had been connected with the Pennsylvania since his graduation in 1902 from Lafayette College. He became division engineer in 1920, division superintendent in 1923, and chief engineer of maintenance of way in 1927.

John B. Leeper, formerly manager of the transmission tower department of the American Bridge Co., died on Dec. 3 at the age of 68 years. Mr. Leeper graduated from Lafayette College in 1892. In 1897 he became associated with the Keystone Bridge Works of Pittsburgh, which later merged with the American Bridge Co., taking up transmission tower work in 1908. Mr. Leeper retired in 1933.

Edmund S. Davis, formerly chief engineer of the Boston Transit Commission, died on Dec. 17 in Jamaica Plains, Mass., at the age of 87 years. Mr. Davis was connected with the Boston Transit Commission from the time of his appointment in 1894 as assistant engineer until he retired in 1920. He became chief engineer of the commission in 1911. The Tremont St. subway, the East Boston tunnel, and the Washington St. tunnel were built under his supervision.

WILLIAM CAMPBELL, 60, professor of metallurgy at Columbia University, died in New York City on Dec. 16. Professor Campbell, born in England, was a graduate of Kings College, London, in 1892, and also studied at St. Kenelm's College, Oxford, until 1894. He held the degrees of BS, MS, and DS, from the Durham University College of Science and was for several years a research scholar at the Royal School of Mines, London. He came to Columbia University in 1902 as a university-fellow, receiving his full professorship in 1914. He became Howe professor in the school of mines in 1924. From 1907 to 1911, Professor Campbell was metallographer for the United States Geological Survey and from 1911 to 1921 for the Bureau of Mines. He was a member of the advisory committee of the U. S. Bureau of Standards and of the committee on alloy steels of the National Research Council and was advisory metallurgist for the New York City Board of Transportation.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $49,856,000, representing a short week due to the Christmas holiday. This total compares with $39,853,000 a week ago and $64,307,000 a year ago. It comprises private work at $33,657,000; public, $16,199,000; federal, $2,062,000; state and municipal, $14,137,000. Corresponding values a week ago are: total, $39,853,000; private, $22,767,000; public, $17,086,000; federal, $1,466,000; state and municipal, $15,620,000. A year ago the volume corresponding to this week's value was: total, $64,307,000; private, $7,059,000; public, $57,248,000; federal, $40,216,000; state and municipal, $17,032,000. The large private volume this week is due largely to purchases by the railroads of new rails and track supplies.

Public and industrial buildings, unclassified, bridges and highways all show gains this week. The classified subtotals are: industrial buildings, $8,710,000; commercial buildings, $3,615,000; public buildings, $3,522,000; highways, $6,195,000; bridges, $4,689,000; sewerage, $510,000; waterworks, $605,000; earthwork, drainage, $882,000; unclassified, $21,128,000.

The larger projects for the week include:

Pulp mill, 3rd unit, Union Bag and Paper Co., Savannah, Ga..	$3,000,000
Warehouse, day labor, Gary Works, subsidiary U. S. Steel Corp., Gary, Ind.............	750,000
Sugar refinery, day labor and separate contracts, Corn Products Refining Co., Pekin, Ill..	2,000,000
Apartment, Spuyten Duyvil Towers, Inc., Kapoch St. near Johnson Ave., New York, N. Y.	800,000
Broadcasting station, Columbia Broadcasting Co., Los Angeles, Calif.	750,000
Library, Department of Interior, Washington, D. C..........	978,000
Highways, North Carolina.....	1,419,000
Highways, Indiana	839,000
Substructure and superstructure bridge over Ohio River, Cairo Bridge Commission, Cairo, Ill.	1,602,000
Grade Crossing elimination, Delaware, Lackawanna and Western R. R., Transit Road, Depew, N. Y................	500,000
Transmission line, 30 mile, separate contracts, West Penn Power Co., Pittsburgh, Pa...	700,000
Track work, improvement and maintenance of tracks, day labor and separate contracts, Great Northern Ry..........	10,000,000
Rails and fastenings, Great Northern Railway	1,750,000
155,000 tons rails, tie plates, angle bars, etc., Atchison, Topeka and Santa Fe Railway, Los Angeles, Calif...........	6,135,000
40,000 tons rails, Norfolk and Western Railway, Norfolk, Va.	1,500,000

New capital is higher this week for both state and municipal bonds, $6,833,000 and corporate security issues, $6,158,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Dec. 1935	Average Prev. 4 Weeks	Week Dec. 24 1936
Federal Government	$14,735	$6,969	$2,062
State and Municipal	37,038	21,766	14,137
Total public....	$51,773	$28,735	$16,199
Total private ..	7,103	27,157	33,657
Week's total ..	$58,876	$55,892	$49,856

Cumulative to date:
1935 . . $1,590,151,000 1936 . . $2,343,825

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1936	Week Dec.24	Cumulative
State and municipal	$6,833	$502,331
PWA non-federal..	.....	164,727
RFC loans	.....	26,663
Corporate issues...	6,158	250,436
PWA loans, Private	.....	—1,665*
Total Non-Federal	$12,991	$942,492
Federal		691,237
Federal	.....	......
Total new capital	$12,991	$1,633,729

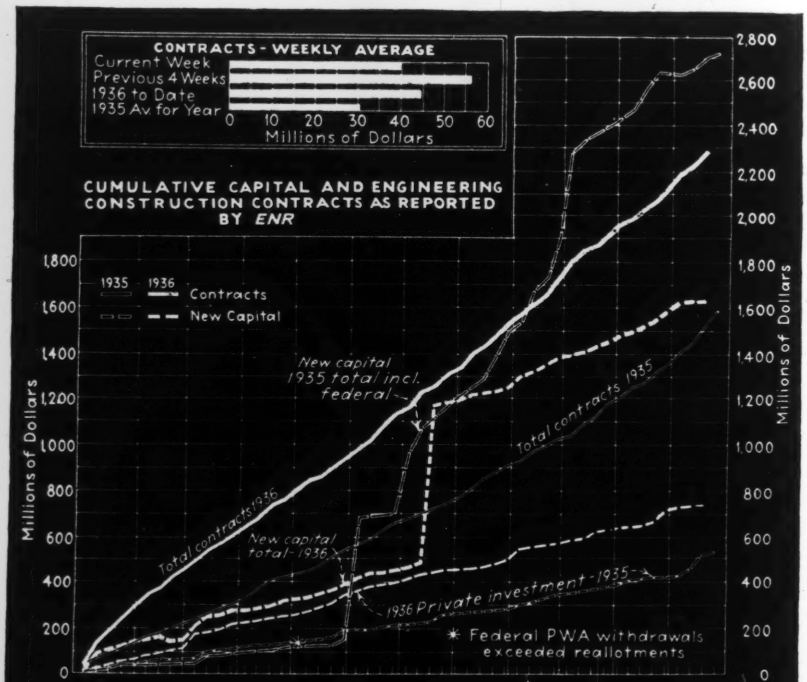
Cumulative to Date
1935 . . $2,738,034,000 1936 . . $1,633,729,000

* Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Dec., 1936..	220.67	106.07	Nov., 1936..	159	70
Nov., 1936..	212.70	102.24	Oct., 1936..	178	78
Dec., 1935..	194.90	93.69	Nov., 1935..	171	75
1935 (Av.)..	195.22	93.84	1935 (Av.)..	135	58
1934 (Av.)..	198.10	95.23	1934 (Av.)..	114	50
1933 (Av.)..	170.18	81.80	1933 (Av.)..	102	47



Current Construction Unit Prices

Dredging in New England

EIGHT projects under the jurisdiction of the U. S. Army Engineers at Boston and Providence, involving $3,500,000 in contract awards since June, 1936, show the trend of dredging prices in the New England area. The projects, extending over wide areas in Massachusetts and Connecticut, range in size from a 46,000-cu.yd. job in Chatham Harbor, Mass., to channel deepening in Cape Cod Canal amounting to 8,990,000 cu.yd. The following tabulations list the three low bidders on each project. The district engineers are Col. A. K. B. Lyman, Boston, and Col. Mason J. Young, Providence.

I—Black Rock Harbor, Cedar Creek, Poquonock River, Conn.
Bids Aug. 12, 1936; channel 20,180 ft. long, 100 to 230 ft. wide, from 13 to 19 ft. below mean low water.

(A) Lavigne & Smith, Inc., Providence, R. I., Sect. 2 & 3 (contract)	$36,647
(B) Geo. W. Sunderlin, Inc., Bridgeport, Conn., Sect. 1 (contract)	31,020
(C) J. S. Packard Dredging Co., Boston, Mass., Sect. 1, 2 & 3	79,048

	Unit prices		
Items	A	B	C
Section 1—94,000 cu. yd.	$0.2988	$0.33	$0.42
Sections 2 and 3—147,000 cu. yd.	.2493	.31	.328
Combined sections 1, 2 and 3—241,000 cu. yd.	....	.31	.328

II—Connecticut River below Hartford, Conn.
Bids Sept. 4, 1936; bars and shoals only over a 50-mile stretch, 150 to 300 ft. wide, 15 ft. below mean low water.

(D) Atlantic, Gulf & Pacific Co., New York City (contract)	$229,926
(E) J. S. Packard Dredging Co., Boston	306,423
(F) Constructors & Engineers, Inc., Chicago	382,942

	Unit prices		
Item	D	E	F
Sections 1 and 2 combined—1,609,000 cu. yd.	$0.1429	$0.1892	$0.238

III—Housatonic River, Conn.
Bids Sept. 16, 1936.

(G) Bay State Dredging & Contracting Co., Boston (contract)	$13,110
(H) H. T. Gerrish, Boston	16,302
(J) J. S. Packard Dredging Co., Boston	24,510

	Unit prices		
Item			
Total project—57,000 cu. yd.	$0.23	$0.286	$0.43

IV—Vineyard Haven Harbor, Mass.
Bids Aug. 28, 1936.

(K) H. T. Gerrish, Boston (contract)	$28,162
(L) North Atlantic Dredging Co., East Boston, Mass.	28,994
(M) Morris & Cumings Dredging Co., New York City	38,760

	Unit prices		
Item	K	L	M
Total project—133,000 cu. yd.	$0.214	$0.218	$0.414

V—Chatham Harbor (Stage Harbor) Mass.
Bids Sept. 11, 1936.

(N) J. S. Packard Dredging Co., Boston (contract)	$21,160
(O) H. T. Gerrish, Boston	22,356
(P) Bay State Dredging & Contracting Co., East Boston, Mass.	35,420

	Unit prices		
Item	N	O	P
Total project—46,000 cu. yd.	$0.46	$0.486	$0.77

VI—Norwalk Harbor, Fivemile River, Conn.
Bids Sept. 7, 1936.

(Q) J. S. Packard Dredging Co., Boston (contract)	$30,769
(R) H. T. Gerrish, Boston	32,668
(S) Morris & Cumings Dredging Co., New York City	38,760

	Unit prices		
Item	Q	R	S
Total project—403,000 cu. yd.	$0.149	$0.1582	$0.1877

VII—Stamford Harbor, Conn.
Bids Sept. 9, 1936; 2½ mile stretch, scow disposal 1 mile.

(T) J. S. Packard Dredging Co., Boston (contract)	$ 99,541
(U) Geo. W. Sunderlin, Inc., Bridgeport, Conn.	99,944
(V) Morris & Cumings Dredging Co., New York City	110,825

	Unit prices		
Item	T	U	V
Total project—403,000 cu. yd.	$0.247	$0.248	$0.275

VIII—Cape Cod Canal, Onset Bay, Mass.
Bids June 2, 1936; 9 mile stretch, 100 to 390 ft. wide, 17 to 32 ft. below mean low water.

(W) M. A. Breymann Dredging Co., New York City, Sect. 1 (contract)	$1,347,718
(X) Great Lakes Dredge & Dock Co., New York City Sect. 2 (contract)	1,723,893
(Y) Arandel Corp., Baltimore, Md., Sect. 1 & 2 comb.	3,347,549

	Unit prices		
Item	W	X	Y
Section 1—4,047,200 cu. yd. scow meas.	$0.333	....	....
Section 2—Remove Bourne bridge piers	....	$30,950	....
—4,942,900 cu. yd. scow meas.	....	0.3425	....
Sect. 3 (1 & 2 comb.)—8,990,100 cu. yd.	..	..	$0.3688
—Remove bridge piers	..	....	32,000

* * *

Paving, Massachusetts Highways

FOUR reinforced concrete bridges and 8½ mi. of penolithic type paving, 56 to 88 ft. wide, now under construction in Massachusetts at a cost of $2,500,000, were awarded in October, 1936, by the Commissioner of Public Work and reveal only slight cost variations in the different road construction alternatives. The location, dimensions, unit prices and totals of the three low bidders on each of the three projects are given in the following tabulations.

I — Lynnfield and Saugus, 4½ miles, 88 ft. wide

(A) B. Perini & Sons Inc., Framingham, Mass. (contract)	$1,349,895
(B) V. Barletta, Roslindale, Mass.	1,383 051
(C) Carlo Bianchi & Co., Inc., Framingham, Mass.	1,555,156

II — Revere, Saugus and Malden, 2½ miles, 60 ft. wide, 2 bridges

(D) C. J. Maney Co., Inc., Boston, Mass. (contract)	$825,178
(E) M. F. Gaddis, Boston, Mass. (Bit. macadam)	851,465
(F) C & R Construction Co., Roslindale, Mass.	871,256

III — Worcester 0.8 miles, 56 ft. wide, 2 bridges

(G) B. Perini & Sons, Inc., Framingham, Mass. (contract)	$325,390
(H) Arute Bros., Bridgewater, Mass. (Bit. macadam)	338,547
(J) Coleman Bros. Corp., Boston, Mass. (Bit. macadam)	344,079

MASSACHUSETTS HIGHWAY PAVING

Item	Description	A	B	C
I — Lynnfield and Saugus				
1.	Earth excavation—204,400 cu.yd.	$0 36	$0.55	$0.95
2.	Rock excavation—93,100 cu.yd	1.80	1.85	.95
3.	Borrow—323,500 cu.yd.	.38	.45	.47
4.	Concrete masonry, cl.D.—161 cu.yd	17.00	15.00	20.00
5.	Concrete masonry, cl. C.—521 cu.yd.	17.00	15.00	21.00
6.	Broken stone roadway base—9,510 cu.yd.	3.15	3.25	3.80
7.	Vitrif. clay pipe, 6 in.—704 lin.ft.	.40	.30	.40
8.	Vitrif. clay pipe, 10 in.—4,122 lin.ft.	.60	.55	.65
9.	Vitrif. clay pipe, 12 in.—8,976 lin.ft	.70	.70	.65
10.	Vitrif. clay pipe, 15 in.—6,166 lin.ft.	1.00	1.00	1.00
11.	Vitrif. clay pipe, 18 in.—2,058 lin.ft.	1.35	1.25	1.35
12.	Vitrif. clay pipe, 24 in.—1,684 lin.ft	2 35	2.25	2.40
13.	Catch basins—292, each	55.00	65.00	70.00
14.	Stone curb inlets—151, each	15.00	12.00	18.00
15.	Riprap—350 cu.yd.	2.00	4.00	2.75
16.	C.M.P. side drains, 6 in.—1,774 lin.ft.	1.20	1.25	1.50
17.	C.M.P. side drains, 10 in.—226 lin.ft	1.70	2.00	2.00
18.	Remove trees—425, each	10.00	12.00	20.00
19.	Sand borrow—2,550 cu.yd.	1.35	1.25	1.40
20.	Str. gravel pits—22,050 cu.yd.	.01	.10	.15
21.	Conc. masonry, cl. A—161 cu.yd.	17.00	17.00	21.00
22.	Stone masonry—1,123 cu.yd.	9.00	8.00	11.00
23.	Stock fence—4,075 lin.ft.	.15	.16	.20
24.	Str. vert. granite curb, 6x18 in.—60,600 lin.ft.	1.00	.95	1.35
25.	Manholes—57, each	55.00	70.00	70.00
26.	Bounds, remove, reset—65, each	4.00	5.00	6.00
27.	Fine gravel, roll, finish—551,000 sq.yd	.05	.03	.04
28.	Reinf. conc. cement, stringers—53,300 lb.	.04	.04	.05
29.	Dry stone masonry—113 cu.yd.	7.00	4.00	10.00
30.	Reinf. conc. pipe, 36 in.—212 lin.ft.	2.50	5.00	3.25
31.	Remove, reset fences—640 lin.ft	.25	.30	.25
32.	Granolithic walks—50 sq.yd.	2.00	3.00	2.50
33.	Remove, reset town line post—1, each	15.00	10.00	15.00
34.	Trench excavation—26,000 cu.yd.	1.25	2.25	1.55
35.	Clear, grub—14.3 acre	100.00	100.00	140.00
36.	Loam borrow—43,700 cu.yd.	1.00	1.00	1.45
37.	Catch basins, manholes—7, each	20.00	25.00	25.00
38.	Catch basin, manhole, frame covers—4, each.	15.00	25.00	17.00
39.	Granite curb inlets—15, each	18.00	16.00	25.00
40.	Reinf. conc. pipe, 12 in.—1,408 lin.ft.	1.30	1.15	1.15
41.	Reinf. conc. pipe, 16 in.—310 lin.ft.	1.55	1.40	1.35
42.	Reinf. conc. pipe, 18 in.—744 lin.ft.	2.15	2.00	2.15
43.	Reinf. conc. pipe, 24 in.—476 lin.ft.	3.25	3.00	3.25
44.	Reinf. conc. pipe, 30 in.—294 lin.ft.	4.00	4.00	4.50
45.	Reinf. conc. pipe, 36 in.—450 lin.ft.	7.00	5.00	9.00
46.	Reinf. conc. pipe, 42 in.—1,484 lin.ft.	8.85	7.00	11.00
47.	C. I. corr. pipe, 15 in.—338 lin.ft.	2.30	2.00	2.60
48.	C. I. corr. pipe, 12 in. heavy—504 lin.ft.	1.85	2.00	2.20
49.	Peat excavation—57,200 cu.yd.	.29	.30	.47
50.	Traffic signal duct—2,720 lin.ft.	.60	.90	.65
51.	Granite curb corners—438 lin.ft.	7.50	6.00	10.00

Current Construction Unit Prices

Item (Continued)	A	B	C
52. Precast edging—43,000 lin.ft.	$ .65	$ .60	$ .75
53. Curved precast edging—1,189 lin.ft.	1.70	1.50	1.80
54. Precast conc. inlets—114, each	20.00	18.00	25.00
55. Curved granite curb, 6 x 18 in.—7,845 lin.ft.	1.35	1.30	1.80
56. Curved granite curb, 5 x 16 in.—830 lin.ft.	.90	1.00	1.20
57. Curb inlets, remove, reset—3, each	10.00	10.00	7.00
58. Cable guard, 6 str. mult., conc. posts—14,670 lin.ft.	.95	1.10	.90
59. Cable gd., 6 str. mult., steel posts—160 lin.ft.	1.10	2.75	1.00
60. Cable gd., 8 str. mult., conc. posts—1,040 lin.ft.	1.10	1.30	1.00
61. Remove, stack guard cable—6,180 lin.ft.	.15	.15	.25
62. 2 rail guard, conc. posts—230 lin.ft.	.85	1.20	1.00
63. Concrete guard posts—48, each	3.00	4.00	5.00
64. Seeding—154,500 sq.yd.	.05	.07	.05
65. Town line bound—remove, reset—1, each	5.00	15.00	15.00
66. Spec. manholes—9, each	75.00	125.00	150.00
67. Bituminous conc. bridge pavement—220 ton	1.00	8.00	8.65
68. Bitum. conc. sidewalks—1,980 ton	8.00	7.00	8.65
69. Remove, reset hydrants—18, each	25.00	30.00	30.00
70. Gates, boxes, 6 in.—13, each	30.00	35.00	25.00
71. Gates, boxes, 1 in.—47, each	6.00	9.00	13.00
72. W. I. cmt. lined pipe, 1 in.—54 lin.ft.	2.00	.80	1.35
73. W. I. water pipe, 1 in.—1,780 lin.ft.	.75	.20	.95
74. Corp. cocks, lead goosenecks—19, each	12.00	7.00	15.09
75. C. I. water pipe, 6 in.—2,344 lin.ft.	1.50	1.30	1.60
76. C. I. water pipe, 8 in.—1,630 lin.ft.	2.00	1.90	1.95
77. C. I. water pipe, 10 in.—565 lin.ft.	2.70	2.30	2.80
78. Meter box, remove, reset—1, each	10.00	16.00	25.00
79. Grates, boxes, 6 in., remove, reset—4, each	15.00	23.00	12.00
80. Asphaltic oil, 45 per cent.—10,000 gal.	.08	.15	.09
81. Stock fence gates—3, each	10.00	12.00	10.00
82. Iron pipe fence, 3 rail—138 lin.ft.	3.00	3.50	3.00
83. Rock excan. trenches—3,200 cu.yd.	4.00	5.00	4.00
84. Warrenite bit. pavement, base—186,260 sq.yd.	1.87	1.55	1.80
85. Oiled broken stone, surface—7,790 cu.yd.	4.59	4.20	4.05
86. Bitum. mat. pen. wear surface—224,000 gal.	.08	.12	.145
87. Oiled broken stone, base—2,075 cu.yd.	4.59	4.60	4.05
88. Bituminous mat, pen. base—36,350 gal.	.08	.13	.145
89. Gravel borrow—242,200 cu.yd.	.57	.55	.73

II — Revere, Saugus, Malden

Item	D	E	F
1. Earth excavation—46,600 cu.yd.	.30	.35	.25
2. Bridge excavation—2,930 cu.yd.	3.00	3.00	2.50
3. Rock excavation—39,000 cu.yd.	2.50	1.75	1.80
4. Borrow—354,600 cu.yd.	.45	.55	.50
5. Concrete masonry, cl. D—113 cu.yd.	15.00	15.00	17.00
6. Concrete masonry, cl. C—2,160 cu.yd.	14.00	15.00	15.00
7. Broken stone roadway base—22,220 ton	1.55	1.50	1.50
8. Vitrif. or c.c.s. pipe, 8 in.—314 lin.ft.	.50	.50	.50
9. Vitrif., c.c.s. pipe, 10 in.—4,320 lin.ft.	.60	.50	.50
10. Vitrif., c.c.s. pipe, 12 in.—3,994 lin.ft.	.70	1.80	.55
11. Vitrif., c.c.s. pipe, 15 in.—1,938 lin.ft.	.95	1.20	1.80
12. Vitrif., c.c.s. pipe, 18 in.—14 lin.ft.	2.00	3.00	1.15
13. Reinf. conc. pipe, 12 in.—1,880 lin.ft.	1.15	1.20	1.10
14. Bounds—104, each	5.00	5.00	5.00
15. Catch basins—176, each	65.00	70.00	60.00
16. Curb inlets—134, each	12.00	9.50	10.00
17. Remove, rebuild walls—385 lin.ft.	.50	2.00	.50
18. Riprap—610 cu.yd.	2.00	4.00	2.50
19. Clay, metal side drains, 6 in.—3,588 lin.ft.	1.00	.75	1.00
20. Clay, metal side drains, 10 in.—2,650 lin.ft.	1.25	1.00	1.00
21. Remove trees—106, each	10.00	50.00	10.00
22. Gravel borrow—96,700 cu.yd.	.50	.65	.80
23. Sand borrow—3,500 cu.yd.	1.50	1.30	1.25
24. Strip gravel pits—9,670 cu.yd.	.15	.10	.10
25. Concrete masonry, cl. B40—0.4 cu.yd.	60.00	40.00	60.00
26. Concrete masonry, cl. A—2,193 cu.yd.	18.00	14.00	18.00
27. Stone masonry—673 cu.yd.	8.00	15.00	10.00
28. Stock fence, steel posts—1,000 lin.ft.	.16	.50	.16
29. Timber piles—59,700 lin.ft.	.50	.50	43
30. Granite curb, 6x18 in.—35,875 lin.ft.	.90	.90	.95
31. Manholes—50, each	65.00	70.00	60.00
32. Remove, reset bounds—1, each	10.00	10.00	5.00
33. Lumber sheeting—21,000 F.B.M.	80.00	50.00	80.00
34. Zinc plates—610 lb.	.20	.30	.25
35. Fine grading, roll, finish—260,000 sq.yd.	.03	.04	.03
36. Reinforcing steel, stringers—427,600 lb.	.035	.036	.035
37. Bituminous waterproofing—1,910 sq.yd.	.25	.20	.30
38. Dry stone masonry—180 cu.yd.	9.00	12.00	8.00
39. Remove, reset fence—805 lin.ft.	.30	.30	.40
40. Granolithic walks—460 sq.yd.	2.00	2.00	2.00
41. Town line posts—3, each	12.00	18.00	15.00
42. Concrete curb inlets—9, each	12.00	10.00	10.00
43. Cable guard rail—560 lin.ft.	.55	.80	.45
44. Trench excavation—15,500 cu.yd.	1.20	1.00	1.50
45. Clear, grub—11 acre	100.00	200.00	200.00
46. Channel excavation—4,920 cu.yd.	1.00	1.00	.80
47. Loam borrow—16,000 cu.yd.	0.50	.80	.80
48. Stone masonry, cl. C—130 cu.yd.	15.00	20.00	25.00
49. Catch basins, manholes—14, each	10.00	10.00	5.00
50. Bitum. macadam excavation—1,400 cu.yd.	.50	.40	.60
51. Trench rock excavation—1,000 cu.yd.	4.00	3.00	5.00
52. Peat excavation—42,700 cu.yd.	.30	.35	.40
53. Curved granite curb, 6x18 in.—4,200 lin.ft.	1.20	1.30	1.35
54. Grade sloped edge A—20,100 lin.ft	.65	.65	.80
55. Straight precast conc. edge—860 lin.ft.	1.20	1.10	1.30
56. Curved precast conc. edge—2,435 lin.ft.	1.30	1.35	1.50
57. Stone curb, reset—165 lin.ft.	.25	.40	.40
58. Curved stone inlets—12, each	16.00	14.00	14.00
59. Granite curb corners, 2 ft. rad.—34 each	6.00	5.00	6.00
60. Granite curb corners, 3 ft. rad.—66 each	15.00	12.50	15.00
61. Traffic signal duct—1,160 lin.ft.	.40	.30	.50
62. Reinf. conc. pipe, 15 in.—864 lin.ft.	1.50	1.50	1.25
63. Reinf. conc. pipe, 18 in.—1,388 lin.ft	2.00	2.00	1.80
64. Reinf. conc. pipe, 24 in.—836 lin.ft.	3.00	3.00	2.70
65. Reinf. conc. pipe, 27 in.—148 lin.ft.	3.50	3.50	3.40
Item (Continued)			
66. Reinf. conc. pipe, 30 in.—204 lin.ft.	$ 5.00	$ 3.80	$ [illegible].90
67. Reinf. conc. pipe, 36 in.—386 lin.ft.	6.00	5.00	[illegible].50
68. Reinf. conc. pipe, 42 in.—582 lin.ft.	7.00	5.80	7.00
69. Reinf. conc. pipe, 48 in.—496 lin.ft.	9.00	7.25	9.00
70. Reinf. conc. pipe, 60 in.—124 lin.ft.	14.00	13.00	15.00
71. C. I. water pipe, 10 in.—112 lin.ft.	1.50	1.60	2.00
72. C. I. heavy pipe, 12 in.—560 lin.ft.	1.75	1.60	2.25
73. C. I. light pipe, 15 in.—86 lin.ft.	2.00	2.60	2.60
74. C. I. pipe, 24 in.—488 lin.ft.	3.75	5.20	[illegible].30
75. C. I. pipe, 30 in.—190 lin.ft.	6.00	8.50	8.50
76. C. I. pipe, 36 in.—168 lin.ft.	8.50	10.00	10.25
77. Spec. heavy c. i. pipe, 36 in.—150 lin.ft.	14.00	19.50	20.00
78. C. I. water pipe sewer, 10 in.—12 lin.ft.	2.75	3.00	3.00
79. C. I. water main, 12 in.—360 lin.ft.	3.00	3.50	3.25
80. C. I. water main, 16 in.—440 lin.ft.	4.50	4.25	4.30
81. Vitrif. sanitary sewer, 10 in.—300 lin.ft.	1.00	.70	.60
82. Special manhole A—1, each	125.00	200.00	200.00
83. Special manhole B—1, each	140.00	250.00	250.00
84. Special manhole C—7, each	100.00	200.00	300.00
85. Manhole covers, catch basins—8, each	20.00	25.00	20.00
86. Seeding—62,700 sq.yd.	.04	.05	.04
87. Wood guard, 2 rail—1,010 lin.ft.	.75	.80	.75
88. 2 str. straight tape, conc. posts—13,080 lin.ft.	.85	.90	.85
89. Iron pipe rail fence—104 lin.ft.	3.75	5.50	3.00
90. Concrete excavation—45 cu.yd	3.00	6.00	5.00
91. Asphaltic oil, 45 per cent—2,000 gal.	.10	.10	.15
92. Bitum. conc. surface—840 ton	6.75	7.00	8.00
93. Bitum. conc. bridge surfacing—220 ton	6.50	7.00	7.50
94. Test piles—2, each	300.00	200.00	150.00
95. Steel sheeting—105,000 lb.	.05	.03	.05
96. Membrane waterproofing—509 sq.yd.	1.00	1.25	1.70
97. Gunite—4,200 sq.ft.	.50	.35	.40
98. C. I. blast plates—7,500 lb.	.045	.07	.067
99. Structural steel—338,000 lb.	.04	.046	.043
100. Creosoted timber piles—27,720 lin.ft.	.80	.80	.86
101. C. I. water pipe, 6 in.—90 lin.ft.	1.50	1.70	2.00
102. Vitrif. clay underdrain, 6 in.—113 lin.ft.	1.00	.40	1.00
103. Oiled broken stone, pen. surface—19,490 ton.	2.40	....	2.25
104. Oiled broken stone, pen. base—1,690 ton	2.20	....	2.25
105. Bituminous penolithic surface—256,200 gal.	.08	....	.12
106. Bituminous penolithic base—15,300 gal.	.08	....	.12

III — Worcester

Item	G	H	J
1. Earth excavation—23,300 cu.yd.	.27	.30	.30
2. Bridge excavation—4,210 cu.yd.	.45	.60	1.25
3. Rock excavation—350 cu.yd.	3.00	5.00	3.00
4. Borrow—147,000 cy.yd.	.31	.40	.28
5. Concrete masonry, cl. C—8,723 cu.yd.	9.40	10.00	12.00
6. Broken stone base—4,250 cu.yd.	3.15	3.60	3.40
7. C. I. water pipe, 4 in.—155 lin.ft.	1.00	1.00	1.00
8. Vitrif. pipe underdrain, 6 in.—50 lin.ft.	2.00	1.00	1.00
9. Vitrif. pipe underdrain, 8 in.—122 lin.ft.	.60	1.00	.50
10. Bounds—75, each	5.50	6.00	6.00
11. Remove trees—123, each	7.00	10.00	13.00
12. Gravel borrow—25,550 cu.yd.	.68	.40	.48
13. Sand borrow—1,060 cu.yd.	1.50	1.00	1.00
14. Strip gravel pits—2,555 cu.yd.	.01	.10	.04
15. Conc. bridge fences, posts—46 cu.yd.	50.00	50.00	60.00
16. Conc. masonry, cl. A—879 cu.yd.	19.40	15.00	18.00
17. Granite vertical curb—12,290 lin.ft.	.90	1.15	1.00
18. Remove, reset bounds—9, each	5.00	6.00	4.00
19. Lumber sheeting—11,000 F.B.M.	200.00	60.00	40.00
20. Zinc plates—710 lb.	.19	.20	.50
21. Fine gravel, roll, finish—72,000 sq.yd.	.03	.03	.04
22. Scarify, reshape—850 sq.yd.	.10	.10	.18
23. Reinforcing steel, stringers—212,935 lb.	.04	.035	.04
24. Bituminous waterproofing—2,340 sq.yd.	.30	.25	.30
25. Dry stone masonry—25 cu.yd.	7.00	10.00	8.00
26. Remove, reset curb—984 lin.ft.	.50	.50	.50
27. Granolithic walks—15 sq.yd.	3.00	3.00	2.00
28. Trench excavation—110 cu.yd.	3.00	2.00	2.00
29. Clear, grub—1 acre	100.00	100.00	100.00
30. Loam borrow—4,600 cu.yd.	1.00	1.00	1.00
31. Bitum. conc. sidewalks—570 ton	7.85	8.00	8.00
32. Curved granite curb—1,465 lin.ft.	1.40	1.50	1.50
33. Remove, reset curb corners—8, each	5.00	5.00	4.00
34. Remove, stack curb corners—3, each	5.00	3.00	3.00
35. Peat excavation—3,300 cu.yd.	.35	.30	.48
36. Underpass excavation—765 cu.yd.	3.00	3.00	4.00
37. Rock excav. trenches—325 cu.yd.	3.00	.60	5.00
38. Multiple 6 str. cable, conc. posts—3,325 lin.ft.	1.05	1.00	1.50
39. Chain link fence—345 lin.ft.	1.80	2.00	1.60
40. Seeding—22,000 sq.yd.	.05	.05	.05
41. Traffic signal duct—300 lin.ft.	.60	1.00	1.00
42. Gunite—12,500 sq.ft.	.38	.38	.38
43. Structural steel—833,400 lb.	.052	.0462	.045
44. W. I. blast plates—71,000 lb.	.069	.065	.055
45. Welded iron fences—578 lin.ft.	7.25	7.50	6.50
46. Pipe railing, 2 in.—102 lin.ft.	3.00	3.00	5.00
47. Membrane waterproofing—315 sq.yd.	1.20	1.50	1.50
48. Membrane w. p. for bridge—400 sq.yd.	1.20	2.30	2.00
49. Bitum. conc. bridge surface—188 ton	7.85	8.00	8.00
50. Granolithic surface—70 sq.yd.	2.00	4.00	2.00
51. Metal conduit, 2 in.—427 lin.ft.	.30	.30	.50
52. Metal tile—1,100 sq.ft.	1.13	1.00	1.00
53. Metal floor drains—6 each	10.00	9.00	15.00
54. Abrasive treads—672 each	.75	.50	.50
55. Split ribbed tile—750 sq.ft.	.23	.25	.25
56. Steel rolling doors—2, each	350.00	200.00	175.00
57. Special manholes—2, each	100.00	100.00	175.00
58. Electrical work—total	140.00	300.00	500.00
59. Entrance bldg.—total	1,000.00	1,500.00	1,200.00
60. Oiled broken stone, pen. surface—2,650 cu.yd.	3.15	....	....
61. Bitum. macadam, pen. surface—76,600 gal.	.16	....	....
62. Oiled broken stone, pen. base—570 cu.yd.	3.30	....	....
63. Bitum. macadam, pen. base—10,150 gal.	.16	....	....